ASTRONOMY®

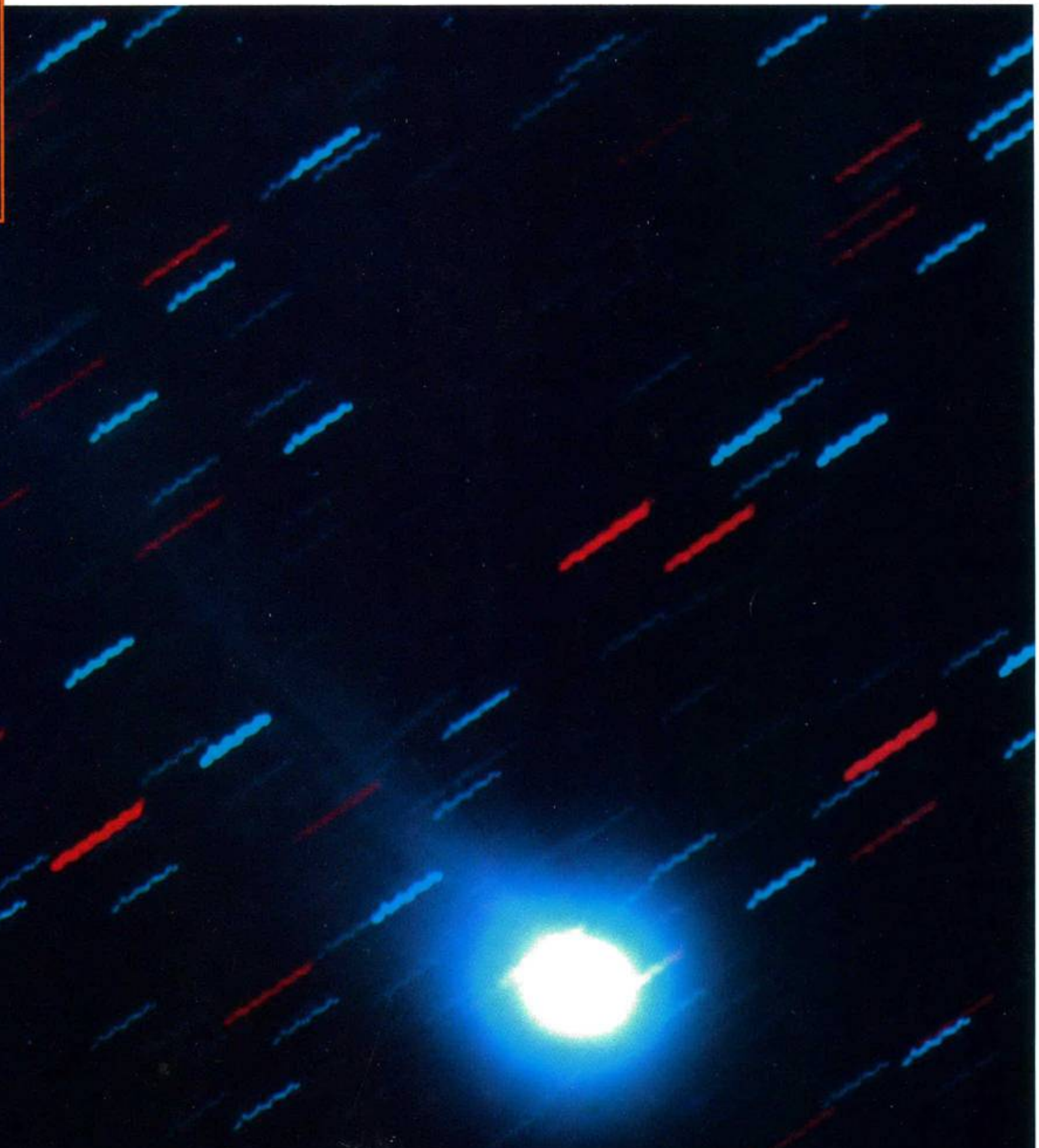
March 1993 U.S. $2.95
U.K. £1.75
Can. $3.50

LOST LAKES OF THE MOON

Discover Springtime Stars

Galileo Looks at Earth

ICD 08070



Comet Swift-Tuttle Returns

03
0 771859 5
08070

MEADE®

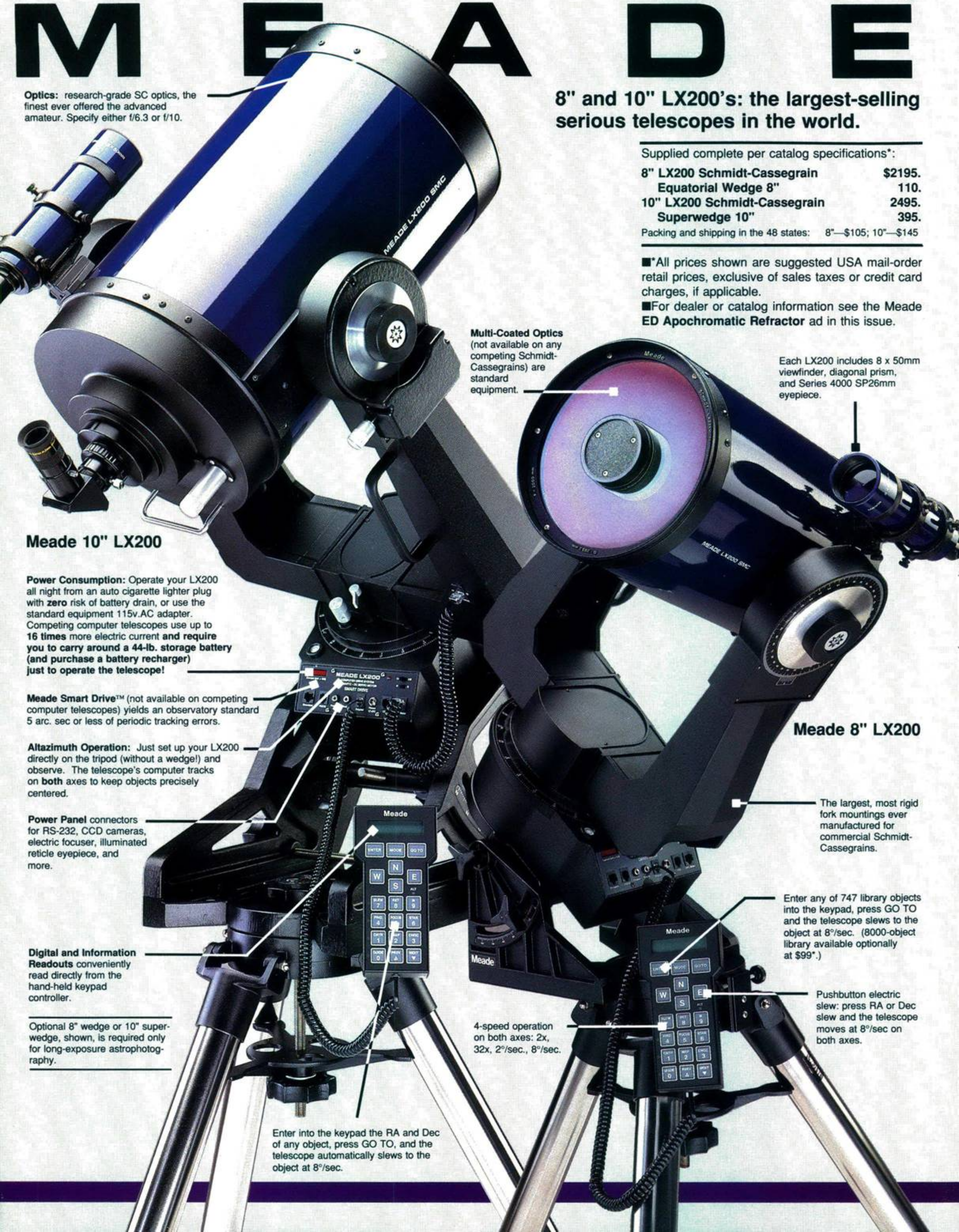
8" and 10" LX200's: the largest-selling serious telescopes in the world.

Supplied complete per catalog specifications*:

8" LX200 Schmidt-Cassegrain	**$2195.**
Equatorial Wedge 8"	**110.**
10" LX200 Schmidt-Cassegrain	**2495.**
Superwedge 10"	**395.**
Packing and shipping in the 48 states:	8"—$105; 10"—$145

■*All prices shown are suggested USA mail-order retail prices, exclusive of sales taxes or credit card charges, if applicable.

■For dealer or catalog information see the Meade **ED Apochromatic Refractor** ad in this issue.



Optics: research-grade SC optics, the finest ever offered the advanced amateur. Specify either f/6.3 or f/10.

Multi-Coated Optics (not available on any competing Schmidt-Cassegrains) are standard equipment.

Each LX200 includes 8 x 50mm viewfinder, diagonal prism, and Series 4000 SP26mm eyepiece.

Meade 10" LX200

Power Consumption: Operate your LX200 all night from an auto cigarette lighter plug with **zero** risk of battery drain, or use the standard equipment 115v.AC adapter. Competing computer telescopes use up to **16 times** more electric current **and require you to carry around a 44-lb. storage battery (and purchase a battery recharger) just to operate the telescope!**

Meade Smart Drive™ (not available on competing computer telescopes) yields an observatory standard 5 arc. sec or less of periodic tracking errors.

Altazimuth Operation: Just set up your LX200 directly on the tripod (without a wedge!) and observe. The telescope's computer tracks on **both** axes to keep objects precisely centered.

Power Panel connectors for RS-232, CCD cameras, electric focuser, illuminated reticle eyepiece, and more.

Digital and Information Readouts conveniently read directly from the hand-held keypad controller.

Optional 8" wedge or 10" superwedge, shown, is required only for long-exposure astrophotography.

Enter into the keypad the RA and Dec of any object, press GO TO, and the telescope automatically slews to the object at 8°/sec.

Meade 8" LX200

The largest, most rigid fork mountings ever manufactured for commercial Schmidt-Cassegrains.

Enter any of 747 library objects into the keypad, press GO TO and the telescope slews to the object at 8°/sec. (8000-object library available optionally at $99*.)

Pushbutton electric slew: press RA or Dec slew and the telescope moves at 8°/sec on both axes.

4-speed operation on both axes: 2x, 32x, 2°/sec., 8°/sec.

OBSERVER REPORTS: *LX200* SCHMIDT-CASSEGRAINS

"...After hours and hours of using this instrument, it is clear the quantum leaps that Meade has made in telescope technology...Planetary contrast and detail were simply unlike any 8" SC telescope that I had ever tested before...The more people looked, the faster word spread that something truly extraordinary was going on..."

"Last weekend I arrived at our club's dark sky site and set up next to a brand-new 8" LX200 owned by Mark, one of our club members. This was going to be a fun evening. Mark punched in a request for M57, the Ring Nebula. Less than 10 seconds later there it was, exactly in the center of the eyepiece! Very sharp image too. Next we tried a long slew, off to M31, the Andromeda Galaxy. Took about 15 seconds and there was the core of M31, again centered in the eyepiece. We punched in a request for Saturn. The scope buzzed over and centered the beautiful ringed planet (this could make a finderscope obsolete!). We ran the power up on Saturn. The LX200 gave a splendid view. Sharp image, lots of contrast. Refractor-like. The optics on this scope were outstanding, and the combination of ease of use and superb optics was impressive. This scope had better contrast and much sharper optics than I've seen on other SC's. One of the club members went inside to call his wife and let her know he was buying one. Congratulations! This is a very desirable scope you've created."—**Bob Beckley, Bedford, MA**

"I have made my best purchase of a lifetime. I saved for two years to have a superior telescope of my dreams and you have made them come true with the 10" LX200. The optical quality one must see to believe. I was actually able to see hints of dust lanes in M31 and spiral structure in M82; my greatest thrills were a confirmed sighting of Pluto and the resolution of M13 into individual stars. I have been in amateur astronomy for 23 years and I have never used such an incredible telescope."—**Michael D. Cloutier, Fair Haven, MI**

"While vacationing over the past week, I've had a chance to put the 8" LX200 through its paces. You've gone beyond the future and into sci-fi with this telescope. I want you to know that the LX200 has exceeded all my expectations, even better than my fondest dreams for a telescope of the future. Congratulations!"—**Roger Ressmeyer, Sag Harbor, NY**

"Because Schmidt-Cassegrain quality has been a personal crusade on my part, I was champing at the bit to test the new Meade 10" LX200. I have always believed that building an excellent Schmidt was within the realm of possibility, and the new LX200 is a real winner. The optics are so good I am now having trouble understanding how you can produce them to the level you have and sell them so inexpensively. I have been "educated" by "optical experts" who said it can't be done. I now have proof that it is possible. Because I know a Schmidt's optics are complex, I always test them with a Ronchi eyepiece as well as real objects. The Ronchi tells if the surface curves are ***accurate*** *and if the surfaces are* ***smooth.*** *Lack of smoothness will kill planetary detail by diffusing light into a hazy cloud around the planet. When I put the Ronchi on the Meade LX200 I couldn't believe what I saw! The bands produced by the Ronchi pattern indicated a surface as smooth as* ***any*** *refractor I have ever seen!! This level of smoothness is incredible in any reflective optical system. The Ronchi bands were also ruler-straight, indicating that the curves on the optics were right-on. No over- or undercorrection. Saturn was magnificent! The planet displayed more contrast and better colour rendition than any Schmidt I have ever owned—and I've owned 8 of them! The equatorial belt was markedly reddish-brown; the Cassini division was darker than I've ever seen it and I could easily see the Crepe ring thanks to the scope's high contrast. Views of deep-sky objects were excellent: M27, M57, and M13 all looked great despite light pollution at the site. The computer drive performed well. I quickly jumped from object to object and turned what was going to be a quick half-hour test into a very enjoyable* ***four-hour*** *observing session. There will be no trade-in of this instrument down the road, because you don't trade in perfection."*—**Richard Anderson, Mississauga, Ontario, Canada**

"At a star party in Austria last weekend I used an 8" LX200 for testing and observations. After hours and hours of using this instrument, it is clear the quantum leaps that Meade has made in telescope technology. Views of Saturn were startling! Planetary contrast and detail were simply unlike any 8" SC telescope that I had ever tested before! Stars were crisp and sharp. The more people looked, the faster word spread that something truly extraordinary was going on: Now people came with their testing tools and a Ronchi-grating confirmed the overwhelming impressions that everyone had during those observations. All lines were absolutely straight. Once the LX200's computer started to let the servomotors hum, the telescope attracted everyone on the observing grounds. I was scanning the heavens and soon people were standing in line to see NGC and Messier objects in rapid succession. Common exclamations were that here was a truly quality telescope that was a joy to use."—**Stefan Thiele, Wiesbaden, Germany**

"The key word to describe my 10" LX200 is versatile. The LX200 is as simple or as sophisticated as my needs dictate. For casual observing I can quickly and accurately move from object to object. The superb optics and smoothness of the mounting make centering objects a visually exciting endeavor, not a fight. When I'm ready to use the technical sophistication of the LX200, the keypad handbox makes finding objects a matter of pushing a couple of buttons. I find that the LX200 makes technology work with me. I also have to mention the excellent support I have received from Meade. Any time I have called with a technical question, I have talked with a "live" person who is not only eager to answer my question but truly concerned with whether or not I am enjoying my scope. I find Meade's approach to business to be truly refreshing."—**Steven L. Renshaw, Fresno, CA**

"I've owned 3 Schmidt-Cassegrains and a 12.5" Newtonian over the years, and recently at our club observatory, I used the most sophisticated commercially-available telescope I've ever seen, the Meade 10" LX200. I was impressed by the sharpness and contrast levels of the LX200. In light-polluted areas of New Jersey the use of a nebular filter is often required to enhance the contrast of deep-space objects, but when I saw the Crab Nebula (M1) clearly through the 10" LX200 ***without*** *a filter, I knew that the optics of the LX200 were obviously of the highest quality. As a result of this experience, I have ordered a Meade 10" LX200 for myself!"*—**John W. H. Simpson, Princeton, NJ**

"As an 8" LX200 owner, I am writing to tell you that I really love the instrument. In side-by-side testing against a friend's [competing brand of] *8" SCT, to say the least there was no comparison. My Meade LX200 was light-years ahead in optical quality and technical capabilities. The LX200 is clearly the best Schmidt-Cassegrain in the world. Period."*—**Jinder Virdee, St. Thomas, Ontario, Canada**

"I recently purchased the Meade 10" LX200 and have been enjoying the scope immensely. You have produced a very high quality product and it has lived up to all my expectations and beyond. The LX200 makes astrophotgraphy a pleasure. The telescope's Smart Drive did a great job of assisting me in the 20-minute photo of M22, enclosed; it took very little effort as the telescope did basically all the work. You can bet I will highly recommend the LX200 to any amateur astronomer looking for a superb telescope."—**Alfredo Garcia, Las Vegas, NV**

"Having just returned from two evenings of viewing on Mt. Pinos, I felt compelled to write you about my experience, as this was my first chance to really take my new 10" LX200 through its paces. What a wonderful combination of superb optics, rigid mounting, and accurate electronics!! I can't remember ever having spent a more enjoyable or productive evening observing! I emphasize 'observing' because that's what the LX200 allowed me to do. Having the telescope slew to my requested objects allowed me to enjoy viewing more objects than I ever thought possible. And speaking of viewing, what great optics! Amazing contrast, pinpoint star images. I have never seen as much detail in the cloud bands of Jupiter. I can't say enough about this scope. It was a breeze to set up (I was aligned, tracking, and observing in 5 minutes). The mounting is VERY solid. This telescope has an amazing array of features, outstanding optics and mounting. You've produced an outstanding product."—**Charles Kuhn, Culver City, CA**

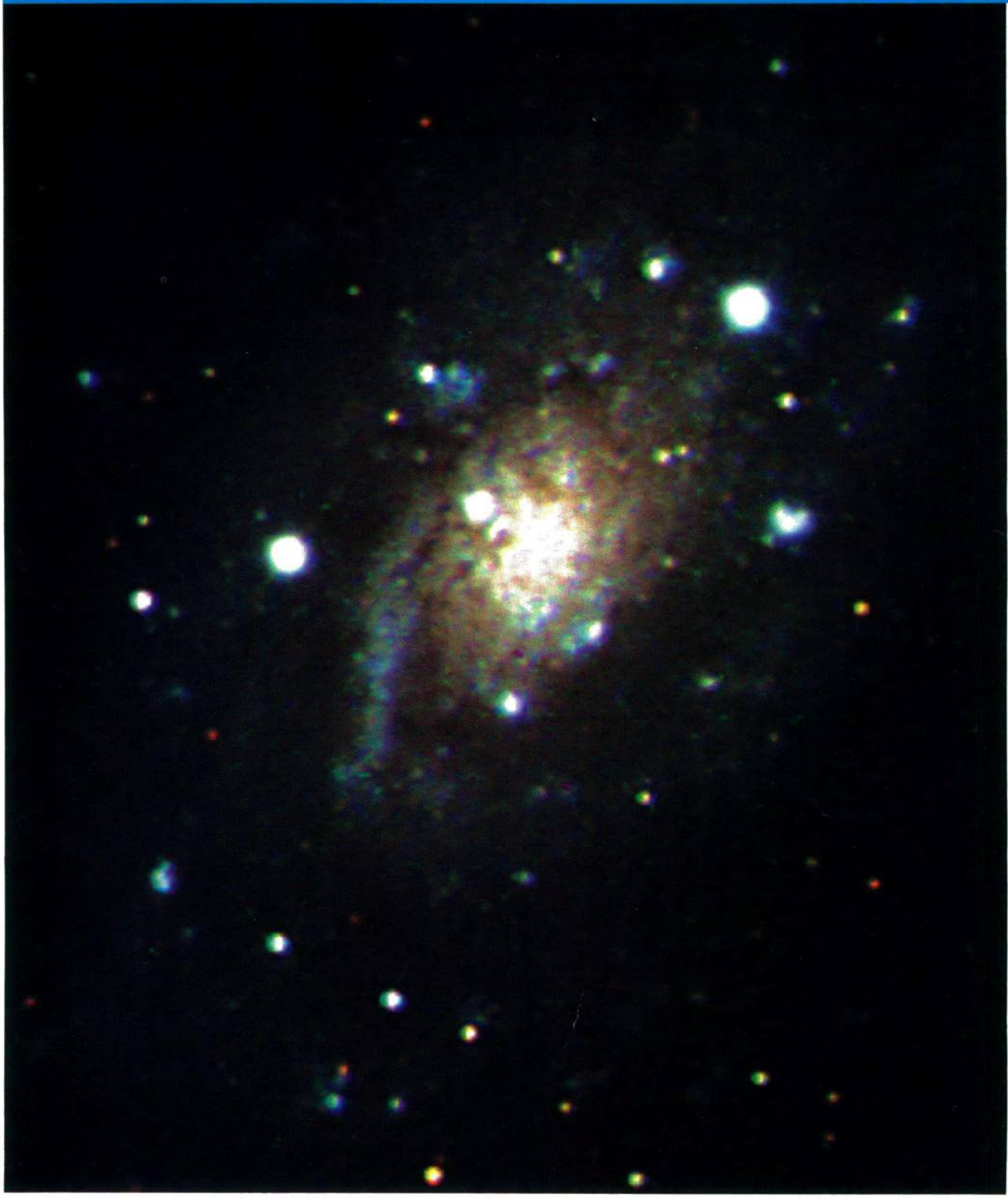
Shouldn't you be using the most advanced Schmidt-Cassegrain ever manufactured? Meade 8" and 10" LX200's are available for prompt shipment. Call or write your authorized Meade dealer today for full details.

ADVANCED PRODUCTS DIVISION
Meade Instruments Corporation
World's Leading Manufacturer of Astronomical Telescopes for the Serious Amateur
1675 Toronto Way, Costa Mesa, California 92626 ☐ (714) 556-2291
FAX: (714) 556-4604

©1992

ON THE COVER: Swift-Tuttle's long, straight tail and large, diffuse coma made it the comet highlight of 1992. See Reader Reports on page 81 for more spectacular images of this recent visitor. Photo by Ronald Royer.

BRIGHT YOUNG CLUSTERS and star-forming regions trace a spiral pattern in this CCD image of the nearby galaxy NGC 2403. You too can take shots like this once you know the tricks of CCD imaging. See page 72.



Jack Newton

20th ANNIVERSARY YEAR

ASTRONOMY

March 1993 **Vol. 21, No. 3**

26 Search for the Lost Lunar Lakes
The eternally dark floors of craters near the Moon's poles may harbor frozen "lakes" of water ice. By Bruce Cordell.

34 Life on an Older Earth
Four billion years from now, Earth residents will see a bigger Sun and a smaller Moon. By Neil F. Comins.

40 Galileo Returns to the Earth and Moon
Galileo's second flyby of the Moon and Earth provided more than a final boost to Jupiter — it also gave us a stunning look at our home planet. By Robert Burnham.

46 ASTRONOMY Sky Almanac

60 Three Handy Observing Aids
Locate the Sun, filter the Moon, and read a star chart at night with these simple do-it-yourself projects.

62 Night of the Deep-Sky Observer
A personal view of spring's best galaxies, clusters, and nebulae. By Jerry Spevak.

66 Exploring the Spring Sky
As the nights slowly grow warmer, spend a few evenings getting acquainted with the spring constellations. By Deborah Byrd.

72 The Digital Darkroom: "Developing" the Image
Learn how to take superb images with the latest CCD cameras. By Richard Berry.

Departments

6 Behind the Scenes
6 Letters
13 Viewpoints
Two Hours with Stephen Hawking
18 AstroNews
Hubble Views Possible Black Hole
21 Space News
New Asteroid Mission
24 Amateur News
Georgia Star Party
81 Reader Reports
Readers Observe Comet Swift-Tuttle
86 AstroBytes
Simulating Gravity
90 Astronomy Books
94 New Astronomy Products
98 Meetings and Events
102 Readings and Credits
106 Advertiser Index

ASTRONOMY (ISSN 0091-6358) is published monthly by Kalmbach Publishing Co., 21027 Crossroads Circle, P.O. Box 1612, Waukesha, WI 53187. Editorial telephone: (414) 796-8776; Advertising and Dealer Orders: (800) 558-1544; Customer Service — Consumer product and subscription inquiries: (800) 446-5489 weekdays 8:30 a.m. to 5:00 p.m. Central Time; Consumer product and subscription orders only: (800) 533-6644, 7 days a week, 24 hours a day; Fax (414) 796-0126. Copyright © 1993 Kalmbach Publishing Co., all rights reserved. Material in this publication may not be reproduced in any form without permission. Second-class postage paid at Waukesha, WI, and additional mailing offices. Allow six to eight weeks for new subscriptions and changes of address. New subscriptions start with the current issue. Subscription price: 1 year, $24. All foreign: add $6 per year; please remit in U.S. funds. GST #R122713209. Send editorial and business inquiries and submissions to the address above. Not responsible for unsolicited materials. ASTRONOMY is indexed in *The Reader's Guide to Periodical Literature* and indexed and abstracted in *Academic Abstracts* and *Magazine Article Summaries.* Microfilms of ASTRONOMY available from University Microfilms, Inc., 300 North Zeeb Road, Ann Arbor, MI 48106. Printed in the U.S.A. POSTMASTER: Send address changes to ASTRONOMY, 21027 Crossroads Circle, P.O. Box 1612, Waukesha, WI 53187. Canadian second-class postal permit no. 545775.

The Audit Bureau

Behind the Scenes

IS THERE A MOUSE IN YOUR DARKROOM?

The digital darkroom has arrived, and astrophotography will never be the same again. On page 72 begins the first of a two-part story on how to take and process images made with cameras that use charge-coupled devices, or CCDs, as their light-sensitive elements.

CCD astrophotography is a new technique that many more amateurs have heard about than have seen firsthand. It bears some similarities to conventional "wet" astrophotography, but it has capabilities that go far beyond what's possible with ordinary film and paper. Richard Berry's article takes you through a night of CCD picture-taking and shows you just how to do it. Next month, he'll explain how to process images on a computer, the vital follow-through step. In conventional terms, this month you take and develop the picture; next month you start making "prints."

Beyond the how-to aspects, the advent of CCDs has raised another issue. CCDs elicit more strong opinions than almost any other topic in backyard astronomy. Those who like them really love them, and those who don't can scarcely conceal their disdain. I suspect this new technology is compelling astrophotographers to think a bit about what they want to get from their efforts at the telescope. And the arrival of the CCD seems to have revealed a hidden fault line within the community of astrophotographers.

Do you glory in beautiful photos that capture the swirling red clouds of hydrogen nebulae? The blue disks and yellow nuclei of spiral galaxies? The wispy tendrils of gas flung off by a supernova? If pictures like these inspire you and drive you to spend hours hunched over a guiding eyepiece, then you probably favor film-based astrophotography. For you, CCD images look crude, have square "grain," and often present an appearance very different from the images you're used to seeing. Moreover, you need a computer to view them.

If, on the other hand, picture-taking for you is a means to let your eyes see more, if picture-taking is exploration, if it is less tied to conventional ideas of beauty and is more attuned to a process of discovery — then CCD imaging is very exciting indeed.

In the quarrel over aesthetics versus discovery, which is right? Of course no one can say, because both are right. Each person will decide on their own which is right for them. Looking ahead, I hope that as equipment becomes more affordable and techniques more familiar, we'll see the fault line heal itself.

By the way, I want to take an informal poll on what amateur astronomers should call picture-taking by CCD. Do you think this activity needs a new name? For instance, should we call it something like electronography? Or astro-imaging? Or are you most comfortable with calling the whole business — film and CCDs — by the time-hallowed name of astrophotography? Whatever your thoughts are, we'd like to hear them, so please drop us a line and we'll publish your responses.

Sincerely,

Robert Burnham
Editor

ASTRONOMY

Robert Burnham Editor
Rhoda Sherwood Managing Editor
Alan Dyer Associate Editor
David J. Eicher Associate Editor
David H. Bruning Associate Editor
Richard Talcott Assistant Editor
Christine Reel Editorial Secretary
Tracy Staedter Editorial Secretary

Thomas L. Hunt Art Director
Jane B. Lucius Art Director Admin.
Patti L. Keipe Graphic Designer
Sabine Beaupré Graphic Designer

Walter J. Mundschau President
Robert A. Maas Publisher
Marc Liu Circulation Director
William R. Edgar Managing Art Director
Karin O. Frederickson Production Director

Daniel R. Lance Advertising Director
Kimberly A. Bennett Advertising Sales Manager
Elizabeth Weber Advertising Services Representative
Advertising Department (800) 558-1544
Joel Park The Environmental Magazine Network,
(908) 671-4036

U.S. and International Newsstand Distribution
I.C.D., The Hearst Corp., New York, NY 10019
Canadian Newsstand Distribution
Telemedia Dist., Toronto, Ontario M4S 3B3

Letters

Palomar's Engineering Wonder

William J. McPeak captured in the capsule space of an article much of the splendor and excitement my generation felt for the 200-inch Hale telescope ("Building the Glass Giant of Palomar," December 1992). I can remember reading a source not listed in your readings that formed my teenage impressions of Palomar, a source with the space for a more leisurely account of telescopes, people, glass, and steel, and one that revealed a spirit akin to McPeak's: "Great men, famous companies, unknown men — all felt the importance, the honor of being allowed to share in this famous project." That is how Helen Wright looks at Palomar in her 1952 book *The World's Largest Telescope*.

It was "an epic in time," she continues, "an epic built by a hundred brains and a thousand hands, guided by a man with profound faith and infectious enthusiasm, who made everyone believe anything was possible."

Yet the Hale telescope is no longer the largest. At 13, I hoped to one day see the Glass Giant of Palomar. Now I one day hope to see the telescopes in Arizona, Chile, and Hawaii and marvel at the instruments we have in Earth orbit.

Both McPeak and Wright produced gentle histories. Today, the pride of participation would be replaced by competition for profit. It leaves me to wonder whether McPeak and Wright, so awed by Hale, could surround today's telescopes with such an aura. Am I merely growing old, or are we indeed losing something valuable, even as we continue to realize Hale's dreams? — *L.B. Cebik, Knoxville, Tennessee*

Universe, Here We Come . . .

I found the prospects of the new search for extraterrestrial life mentioned in Seth Shostak's article ("Listening for Life," October 1992) and Robert Burnham's editorial intriguing. I found it curious, however, that the search began on the 500th anniversary of Columbus' landing in the Americas. This event warrants no celebration in the minds of many people. Columbus' "discovery" marked not only the beginning of one civilization, but the end of another. When or if we find the "jeweled shores" of another world, will we refrain from imposing the values and culture of our world upon them? — *Gloria A. Villalobos, Pullman, Washington*

Why must the white man conquer,

[continued on page 12]

550 BC: Anaximander invents the star chart.

1992 AD: The_Sky for Windows fine tunes the concept.

Now you can open your Windows to a whole new universe. A universe bursting with more stars and deep-sky objects than any other astronomy program devised since Anaximander himself first looked into the sky.

Because now, when you look into The_Sky for Windows you'll see 10,000, or 45,000, or even 272,000 objects, depending on which level you buy. Stars, planets, Messier and NGC objects, all of them easily identifiable.

And you'll warp through this universe, at speeds up to 100 times faster than the finest competing programs. Using our exclusive plotting technology, zoom to any portion of The_Sky you like in less than a second, with or without a math coprocessor.

It's a universe bursting with color, too. The_Sky powers your graphics hardware to its fullest potential, using any device supported by Windows, from CGA through 1024 x 768-pixel 256-color Super VGA and even beyond. No other program provides so wonderfully detailed or spectacularly colorful a show.

And speaking of spectacular, wait until you see the professional-quality star charts you can output to any Windows-supported printing device. Customize them to your own specifications by type, magnitude, constellation and/or grid lines, labels, SAO numbers — a galaxy of options.

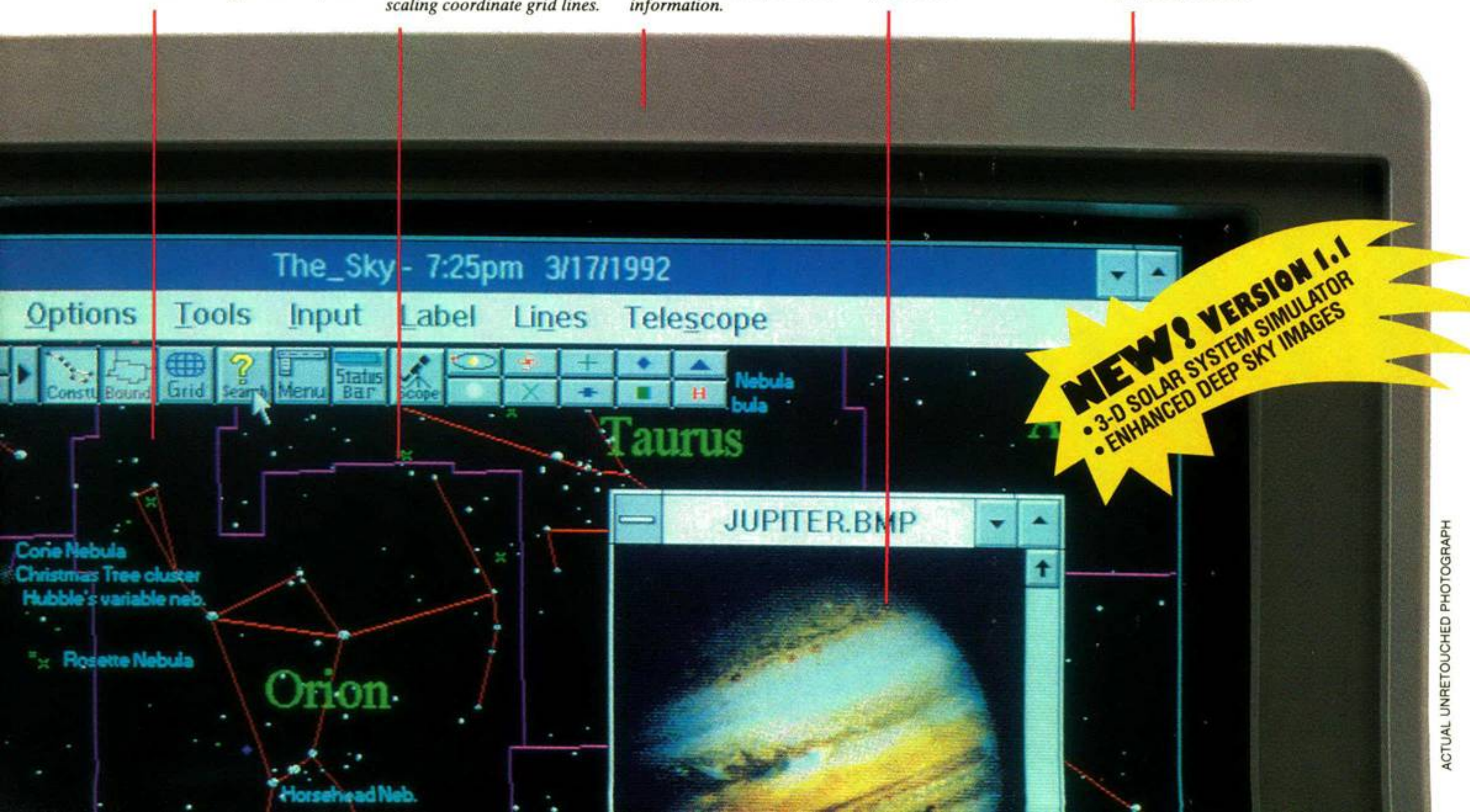
There's one more option we doubt you'll ever want to use: a 60 day money back guarantee.

So remember. For the most dazzling display yet of the heavens on a computer, The_Sky's the limit.

The_Sky™ Astronomy Software

Software Bisque *912 Twelfth Street, Suite A*
Golden, Colorado 80401 1. 800. 843. 7599
FAX: 303. 278. 0045

Also available for DOS


The_Sky - 7:25pm 3/17/1992
Options
Tools
Input
Label
Lines
Telescope
Constl
Bound
Grid
Search
Menu
Status Bar
Scope
Nebula
Taurus
JUPITER.BMP
Cone Nebula
Christmas Tree cluster
Hubble's variable neb.
Rosette Nebula
Orion
Horsehead Neb.
NEW! VERSION 1.1
• 3-D SOLAR SYSTEM SIMULATOR
• ENHANCED DEEP SKY IMAGES

Dynamically scroll and zoom through the sky. No more waiting for screen plots.

Quickly navigate the heavens using constellation lines and boundaries, auto-scaling coordinate grid lines.

Point and click on any object at any zoom level to display a wealth of detailed information.

Display full-color images of celestial objects — even add your own.

Enter time skips for fascinating shows of the planets in motion.

ACTUAL UNRETOUCHED PHOTOGRAPH

OBSERVER REPORTS: *ED* APOCHROMATIC REFRACTORS

Never in the 20-year history of Meade Instruments has a new telescope series been so thoroughly tested—and received such acclaim—by some of the world's most demanding and discriminating astronomers. A sampling of the reports we have received on Meade ED Apochromats:

"As an apochromat **and** *Schmidt-Cassegrain enthusiast of 22 years standing, I have been more than a bit anxious to get my hands on the new Meade APO's and LX200 SCT's. I think it is paramount that a "mainstream" company has gotten involved in the development of apochromatic refractors, so the average person does not have to pay a fortune and wait almost a year to get a quality, high-performance refractor. With some friends, I recently put the Meade 4" 102ED and 10" LX200* [See the Meade LX200 ad of this issue] *through extensive testing. The 4" was virtually perfect. The mount was very solid and the computer drive made finding objects in light-polluted North York very easy. The fast electric slew feature was much appreciated because it eliminated the need ever to loosen the RA and Dec locks. Set-up and orientation of the scope were easy as well. The optics: all I can say is "superb." We looked at Saturn, Epsilon Lyrae, M13, and other Messier objects, and all were excellent. I could not believe the colour correction I was seeing: I detected no on-axis colour whatever. We took the scope up to 360X and the image did not degrade at all. Saturn was very detailed and the contrast of the equatorial band on the planet and the variation in the planetary colours was amazing for a 4" refractor. The double-double was like four "bullet holes" and showed not a hint of the astigmatism or overcorrection I have seen in so many other APO's claiming to be "state-of-the-art." The Meade 102ED is a remarkable scope. Any scope that can support almost 100X per inch is a first rate instrument—I have seen too many other APO's fall apart at 50X and even 30X per inch."*—**Richard Anderson, Mississauga, Ontario, Canada**

"Further to my letter regarding your 4" APO, I thought you might like to hear the results of tests on your 5" APO at the recent Canadian Starfest convention. Through the 5" Saturn was terrific. Aside from the usual things such as the Cassini division, I could see the olivine cap on top of the ball, as well as subtle detail in the main equatorial belt. What really struck me as amazing was the true-to-life colour rendition the APO provided. ***The colour correction of the Meade 5" is as perfect as I've ever seen in a refractor.*** *When I compared the Meade APO to a few* [competing brand of] *refractors, I was seriously wondering why anyone would pay the prices they charge—on all objects the Meade was as good or better. The diffraction disks of stars were more accurately rendered in the Meade than in the* [competing brand of] *6" APO at the site. I can wholeheartedly recommend the Meade 5" APO. In terms of comparison to other brands on the market, the Meade is superior."*—**Richard Anderson, Mississauga, Ontario, Canada**

"I've been an amateur astronomer since 1959 and have observed through all manner of telescopes large and small, up to 40" aperture. I am writing to tell you that images through the Meade 6" ED/APO are absolutely stunning even by professional standards. Image contrast and definition are amazing. The quality and workmanship are flawless. Having joined the A.L.P.O. in 1965, I can only speculate on how much additional and useful observational work could have been accomplished, had quality apochromatic refractors such as this been available those many years. The image quality even to the edge of the field is outstanding, while the color correction and contrast are simply better than any telescope I've ever used."—**Orville H. Brettman, Past President, The Astronomical League, Huntley, IL**

"In this country where apochromatic refractors are used by almost half of all serious amateurs, the introduction of Meade American-made ED/APO refractors was frankly met with some skepticism. This skepticism has dissolved rapidly, however, as word has spread about these very fine instruments. My personal tests with the Meade 5" ED have proven that this lens is clearly the equal of the finest Japanese ED lenses. Images through the Meade 5" ED are of high contrast and I could see no false color even at high power. Diffraction rings are virtually perfect. Using the computer drive, the telescope centered objects automatically and greatly increased my observing efficiency. Thank you for giving Japanese amateurs a chance at reasonable cost to use high-performance, large-aperture ED refractors."

—**Tadashi Sudoh, Tokyo, Japan**

"Last night I used the new Meade 6" and 7" ED apochromatic refractors. These are, without a doubt, among the finest telescopes I've ever used. Period. The LXD 700 equatorial mount is truly a remarkable telescope mount. The computer control is no less than startling. After spending 3 minutes polar aligning the mount, I then entered the command to find Saturn. The motors of the huge 7-incher slewed directly to the planet and placed it exactly in the center of the field of the 4.7mm eyepiece. And the views: I have never seen such razor-sharp images of Saturn before. Both scopes gave exceptional images. Stars are like tiny pinpoints. I could go on and on, but suffice it to say, these telescopes are really astounding."—**Darrell Green, Burbank, CA**

"I just wanted you to know how thrilled I am with my new 4" 102ED refractor. My standards for precision optics are exceedingly high; I am an eye surgeon and routinely use an $80,000 state-of-the-art microscope to perform cataract surgery. I'm happy to say that every aspect of the scope lives up to my standards and expectations. The mount is extremely rigid with excellent vibration dampening characteristics. The #1697 computer drive performs flawlessly. Lastly, and most importantly, the optics are superb. Planetary and lunar contrast and detail are simply breathtaking. My sincere thanks for the obvious thought and dedication that your company put into this magnificent precision instrument."

—**Barry S. Seibel, M.D., Los Angeles, CA**

"I had my first look through the Meade 6" APO at the 1992 Astrofest Star Party. While the lines were long in anticipation, I finally feasted my eyes on Saturn and was literally knocked back by what I saw. Not only was Saturn huge in the 240X field, but almost three-dimensional as well. As I studied the image, I remembered the old saying "Good things are worth waiting for," and this telescope is worth every minute."

—**Vic Winter, Kansas City, MO**

"At a recent star party many apochromatic refractors were set up, including a 6" Meade ED/APO. All during the evening I walked back and forth among these telescopes, carefully comparing relative optical performance. After looking through several 6" [competing brand] *3-element APO's (both cemented and air-spaced designs), I noticed in all of these scopes that Saturn's minor ring divisions, Cassini division, and the ball of the planet were not of the same contrast brightness, but seemed to vary inconsistently. Some areas of the planet seemed "underexposed," while other areas with potential detail appeared subdued. I repeatedly went back to a 3-element 6" f/12* [competing brand] *planetary APO, but found that all of the 3-element APO's had the contrast problem. Amazingly, the Meade 6" f/9 ED air-spaced doublet APO produced a brighter image with increased sharpness, allowing features to be seen more clearly than through competitive triplets. "Brighter, clearer, sharper" is the way I would describe the Meade APO when compared directly to lenses of other designs."*—**Robert Petti, Lyndhurst, OH**

ASTRONOMICS, Norman, OK.
Orders: 800-422-7876; Info.: 405-364-0858.

CALIFORNIA TELESCOPE COMPANY, Burbank, CA.
Orders: 800-843-4780; Info.: 818-505-8424.

FOCUS CAMERA, Brooklyn, NY.
Orders: 800-221-0828; Info.: 718-436-6262.

LUMICON, Livermore, CA.
Orders: 800-767-9576; Info.: 510-447-9570.

SCOPE CITY/Mail-Order Dept., Simi Valley, CA.
Orders: 800-235-3344; Calif. & Info: 805-522-6701

SHUTAN CAMERA & VIDEO, Chicago, IL.
Orders: 800-621-2248; Illinois & Info.: 312-332-2000.

Canada:
KHAN SCOPE CENTRE, Toronto, Ontario.
Orders & Information: 416-783-4140.

☐ **For further information on Meade ED Apochromatic or Schmidt-Cassegrain telescopes, visit one of the hundreds of Meade dealer showroom locations throughout the USA; or contact one of the authorized mail-order dealers at left. Or call Meade Instruments toll-free at 1-800-854-7485 (in California 714-556-2291).**

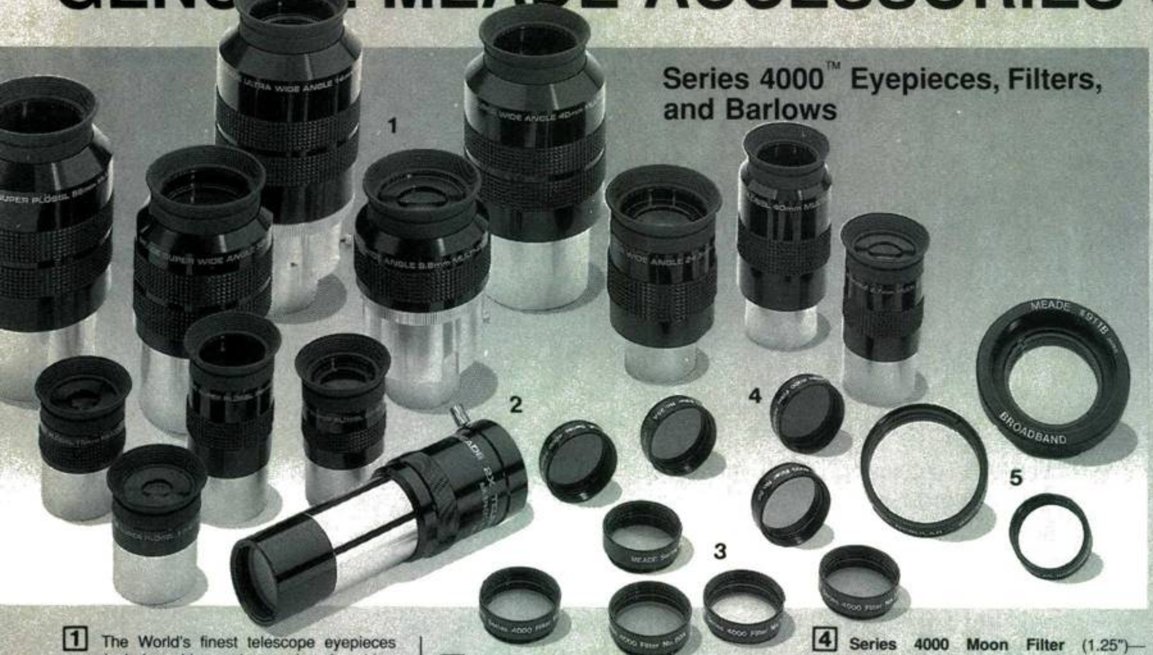
☐ *All prices shown are suggested USA mail-order retail prices, exclusive of sales taxes or credit card charges, if applicable.

☐ The all-new **1992 Meade General Catalog**—$3.00 postpaid—is available from any authorized Meade dealer or directly from Meade Instruments.

ADVANCED PRODUCTS DIVISION
Meade Instruments Corporation
World's Leading Manufacturer of Astronomical Telescopes for the Serious Amateur
1675 Toronto Way, Costa Mesa, California 92626 ☐ (714) 556-2291
FAX: (714) 556-4604

©1992

GENUINE MEADE ACCESSORIES & PARTS



Series 4000™ Eyepieces, Filters, and Barlows

1 The World's finest telescope eyepieces now include rubber grips and soft rubber eyeguards for an even better observing experience! All eyeguards fold down for eyeglass wearers—a feature not available on competing brands. Best of all, **Meade Series 4000's are guaranteed to deliver more field, more contrast, and more image sharpness than any other brand at any price, or your money back.*** For splitting the closest doubles, revealing tenuous, faint nebulosity in deep-space, or studying hairline lunar and planetary detail, Meade multi-coated Series 4000's are the oculars that serious observers insist upon. ***"Clearly the best."***

Super Plössls (5-elements; 1.25"; 52°):
6.4; 9.7; 12.4; 15; 20; 26mm ea **$87.95**(3.29)
32mm(52°); 40mm(44°); each **109.95**(3.79)
56mm (52°, 2") **229.95**(4.18)

Super Wide Angles (6-elements; 1.25"; 67°):
13.8mm: **139.95**(3.29) 18mm: **149.95**(3.29)
24.5mm: **169.95**(3.79) 32mm(2"): **239.95**(4.18)
40mm(2"): **299.95** (4.18)

Ultra Wide Angles (8-elements, 1.25"; 84°):
4.7mm: **154.95** (3.29) 6.7mm: **187.95** (3.29)
8.8mm(1.25"/2"): **229.95** (4.18)
14mm(1.25"/2"): **269.95** (4.18)

*at participating dealers; see catalog for details.

2 **#140: Series 4000 2x Apochromatic Barlow Lens** (1.25")--The original Meade 3-element, air-spaced, multi-coated design. Absolutely unmatched in image resolution and color correction. 28mm dia. lens (26mm clear aperture). **$79.95** (3.29)

3 **Series 4000 Photo-Visual Color Filters** (1.25")—Made of purest crown optical glass, dyed in the mass. For increased contrast on the Moon and planets. Thread into virtually all 1.25" eyepieces sold today. Fully coated.

#8 Lt. Yellow; #11 Yellow-Green; #12 Yellow; #21 Orange; #23A Lt. Red; #25A Red; #38A Dark Blue; #47 Violet; #56 Lt. Green; #58 Green; #80A Blue; #82A Lt. Blue. each **$12.95** (2.29)

Set #1—4 filters: #12 Yellow, #23A Lt.Red, #58 Green, #80A Blue **$49.95** (2.79)

Set #2—4 filters: #11 Yellow-Green, #25A Red, #47 Violet, #82A Lt. Blue **$49.95** (2.79)

Set #3—4 filters: #8 Lt. Yellow, #21 Orange, #38A Dark Blue, #56 Lt. Green **$49.95** (2.79)

Sets #1 & #2—8 filters **$89.95** (3.29)

Sets #1, #2, & #3—12 filters **$129.95**(3.48)

4 **Series 4000 Moon Filter** (1.25")—Excellent for 4" to 12" telescopes. Reduces Moon brightness by 87%. **$15.95** (2.49)

5 **Series 4000 Nebular Filters**—The very latest in multi-layer interference coating technology, Meade premium nebular filters are guaranteed to be the finest obtainable at any price. Use a Series 4000 Broadband filter to block most forms of light pollution, with minimal attenuation of desired wavelengths. Use a Narrowband filter in heavily light-polluted areas, or for extremely high contrast observing of faint nebulae.

BROADBAND FILTERS

#908B (1.25")—Threads into all Meade 1.25" eyepieces, and virtually all other brands. Full 26mm clear aperture. **$79.95**(2.49)

#910B—Threads into all Meade 2" eyepieces and most others; 44mm dia. **119.95** (2.79)

#911B--Threads on to the rear cell of Schmidt-Cassegrain telescopes. **99.95** (3.29)

NARROWBAND FILTERS

#908N (1.25")—Threads into virtually all 1.25" eyepieces; 26mm clear aperture. **89.95**(2.49)

#910N—Threads into all Meade 2" eyepieces and most others; 44mm dia. **129.95**(2.79)

#911N--Threads on to the rear cell of Schmidt-Cassegrain telescopes. **119.95**(3.29)

Rack-and-Pinion Focusers (1.25")

The finest focusers in the industry, Meade rack and pinion mechanisms have precise, ultra-smooth action along the entire travel distance. Housings are machined for tight fit of the moving sleeve. All focuser models may be used on tubes of from 4" to 20" diameter; all accept 1.25" eyepieces. Mounting hardware included.

#71—The finest economical focuser available. Travel distance: 2.2". A precision mechanism, beautifully finished. **$44.95** (2.79)

#67—Includes spring-loaded gearbox for variable tension adjustment. Travel distance: 2.2". **59.95** (2.79)

Rack-and-Pinion Focusers (2")

#680--The most popular 2" focuser ever manufactured. Thousands in use. Spring-loaded gearbox; 3" travel. Includes 1.25" and 2" eyepiece-holders. **99.95**(3.78)

#682—Low-profile 2" focuser; body height only 1.75". Spring-loaded gearbox. Travel: 2.5". Includes 1.25" adapter. **99.95** (3.78)

Viewfinders: 30mm, 50mm, 60mm

#637: 6 x 30mm-Fine, 7° wide-field finder; coated, achromatic lens; crosshair eyepiece, 2-ring bracket with alignment screws. Attaches to tube diameters 6" to 12" **$49.95** (3.29)

#545: 8 x 50mm-(*lower photo*) Wide 5° field; coated achromatic objective; crosshair eyepiece. White tube. Ideal for telescopes of any aperture. See bracket below. **69.95** (4.28)

#544: 8 x 50mm--Same as #545, but in Meade blue. **69.95** (4.28)

#957: 9 x 60mm--(*top photo*) Collects 44% more light than 50mm; superior for faint objects; bracket below. **99.95** (4.68)

Bracket for 8 x 50mm: Fits Meade and Celestron SCT's, and other tubes from 7" to 20" diameter. **17.95** (2.79)

Bracket for 9 x 60mm: Fits tubes from 7" to 20" diameter. Removable dovetail included. **22.95** (2.79)

Multi-Coated Giant Binoculars

Superb, fully multi-coated 11 x 80mm and 20 x 80mm Giant Binoculars, ideal for wide-field deep-space observing. **Rubber-coated bodies for rugged field use!** BAK-4 prisms yield bright, sharp, high-contrast images. Hard carry case, tripod adapter included.

11x80: $399.95(7.27)
20x80: $419.95(7.27)

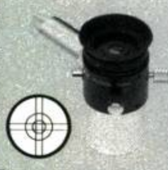
45° Erect-Image Diagonal Prisms

Originally developed by Meade Instruments, these convenient diagonals erect the astronomical image, for terrestrial use of astronomical telescopes. Fully coated.

#927: for .965" focusers.
#928: for 1.25" focusers.
#931 Hybrid: accepts 1.25" eyepieces, fits .965" focusers.

Specify model desired. each **$49.95** (2.79)

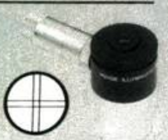
World's Most Advanced Illuminated Reticle Eyepiece



Series 4000 Plössl 9mm, with rubber eyecup and micrometric X-Y positioning of the reticle within the field. Greatly facilitates locking on the guide star. Sharp high-power imaging, excellent eye relief. Wireless red LED illuminator with adjustable brightness control. Internal batteries included. Multi-coated optics. Bullseye reticle. 1.25" **$129.95** (3.29)

Series 4000 Plössl 9mm—Same as above but with 6 ft. cord and plug for Meade LX3, LX5, LX6, LX100, LX200, and APO power panels, in place of wireless illuminator. **$109.95** (3.29)

MA 12mm Illuminated Reticle Eyepiece



Excellent 3-element optical system, long eye relief, fully coated, with double crossline reticle. Includes wireless red LED illuminator with internal batteries and variable brightness control. **$94.95** (3.29)

MA 12mm-Same as above, but with cord and plug for Meade telescopes with power panels, in place of wireless illuminator. **$74.95** (3.29)

2" Diagonal Mirror

#929: Permits use of wide-field 2" oculars. Threads on to rear cell of Meade and Celestron SCT's. Includes multi-coated precision optical flat made at the Meade factory; with 1.25" eyepiece adapter **$99.95** (3.29)

Camera Adapters (1.25" & .965")

Professional-quality adapters for rigid coupling of telescope-to-camera. Use for either Eyepiece-Projection or Prime Focus. Precision-machined of aluminum and brass, threaded for filters. Use with T-Mount, available separately.

.965": **$27.95** (2.79) 1.25": **$29.95** (2.79)

Variable-Projection Camera Adapter (1.25")

Machined sliding cell allows variable projection power in eyepiece-projection photography; permits precise selection of correct photo power in lunar and planetary photography; threaded for filters. Use with T-Mount for your camera. **$39.95** (2.79)

Tele-Extenders

For Eyepiece-Projection photography with any Meade or Celestron SCT. Threads on to eyepiece-holder. Use with T-Mount for your camera.

Basic Tele-Extender:(*above*) Fixed projection power; use with eyepiece for lunar and planetary photos. **$29.95** (2.79)

Variable Tele-Extender: Sliding cell, with lock, permits wide range of projection magnifications with the same eyepiece. **$39.95** (2.79)

T-Adapters for SCT's

For Prime Focus photography with any Meade or Celestron SCT. Use with T-Mount for your 35mm camera. **$26.95** (2.79)

2X Telenegative Barlow (1.25")

#122: Doubles eyepiece power with sharp, high-resolution, high-contrast imaging on telescopes of all types. 27mm dia. (26mm clear aperture). Excellent corrections for chromatic and spherical aberrations at all photo-visual wavelengths. Multi-coated. 1.25" **$47.95** (3.29)

2x-3x Variable Barlow (1.25")

#127: Precision internal sliding lens assembly permits continuously variable power settings between 2x and 3x. Engraved scale indicates power in use. Yields bright, sharp, high-contrast images on telescopes of all types. Multi-coated; 1.25" **$59.95** (3.29)

Orthoscopic Eyepieces (1.25")

Fine 4-element oculars that yield excellent image quality with any telescope. Computer-optimized design provides wide, flat fields, highly corrected for spherical and chromatic aberrations. Parfocal, multi-coated, 1.25" barrels. Threaded for filters. **Focal Lengths: OR 4, 6, 9, 12.5, 25mm.** each **$49.95** (2.79)

Modified Achromatic Eyepieces

An improvement on the traditional Kellner design, the 3-element MA gives sharp, faithful, well-corrected images of the Moon, planets, and deep-space. Multi-coated, threaded for filters. 1.25" **Focal Lengths: MA 9, 12, 25, 40mm.** each **$37.95** (2.79)

HOW TO ORDER

- Prices shown are suggested USA mail-order retail prices and do not include any applicable sales taxes.
- Suggested shipping and handling charges to the 48 states by UPS or US Mail shown in ( ) next to each price.
- Meade accessories may be ordered from any Meade Advanced Products dealer. **The following national mail-order dealers carry all Meade accessories in-stock for immediate shipment:**

ASTRONOMICS, Norman, OK.
Orders: 800-422-7876; Info.: 405-364-0858.

CALIFORNIA TELESCOPE CO., Burbank, CA
Orders: 800-843-4780; Info: 818-505-8424.

FOCUS CAMERA, Brooklyn, NY.
Orders: 800-221-0828. Info: 718-436-6262.

LUMICON, Livermore, CA.
Orders: 800-767-9576. Info: 510-447-9570.

SCOPE CITY/Mail-Order, Simi Valley, CA.
Orders: 800-235-3344; Info/CA:805-522-6701

SHUTAN CAMERA & VIDEO, Chicago, IL.
Orders: 800-621-2248; Info/IL: 312-332-2000.

Canada:

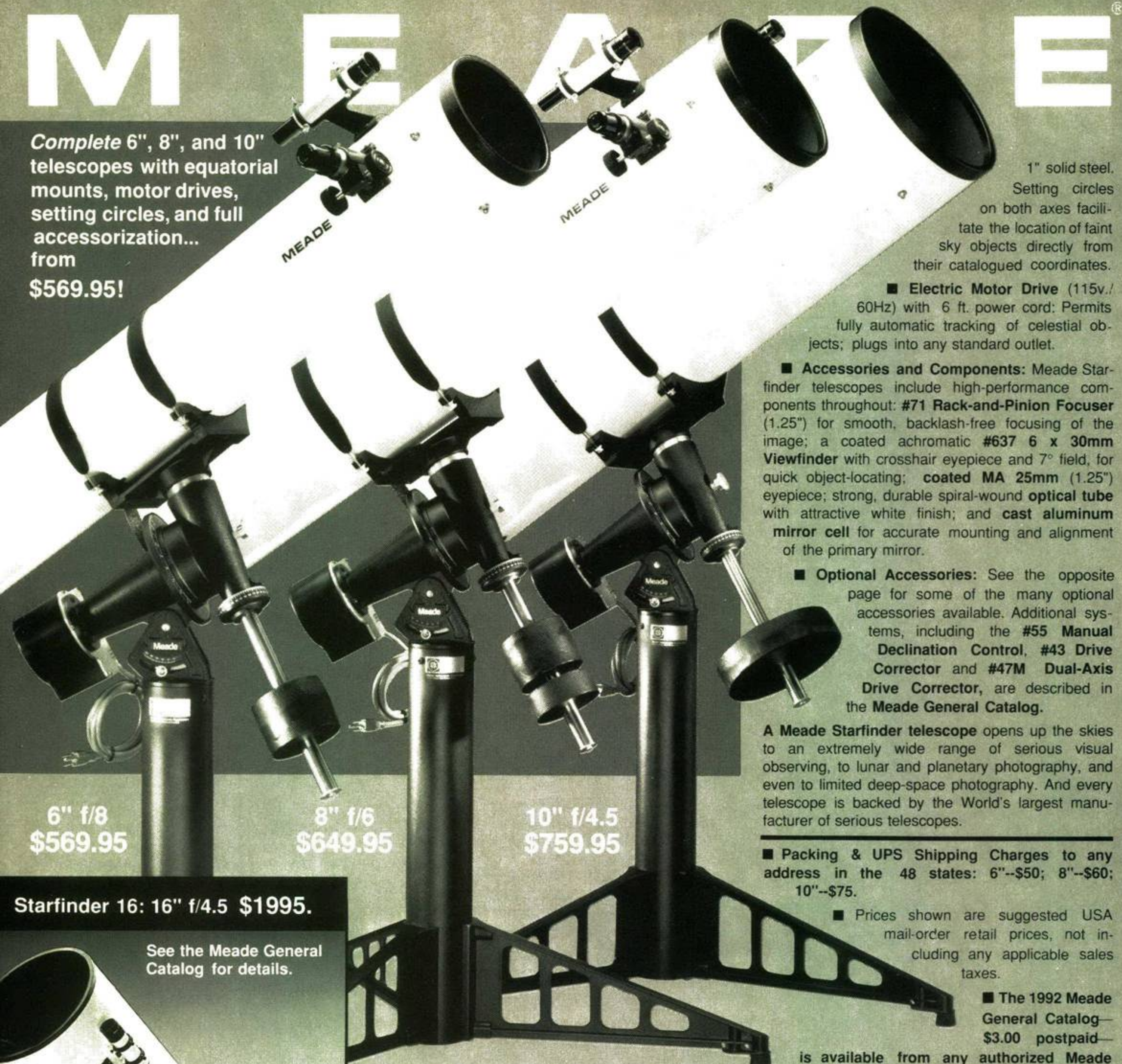
KHAN SCOPE CENTRE , Toronto, Ontario.
Orders & Information: 416-783-4140.

©1993

MEADE®

Complete 6", 8", and 10" telescopes with equatorial mounts, motor drives, setting circles, and full accessorization... from

$569.95!



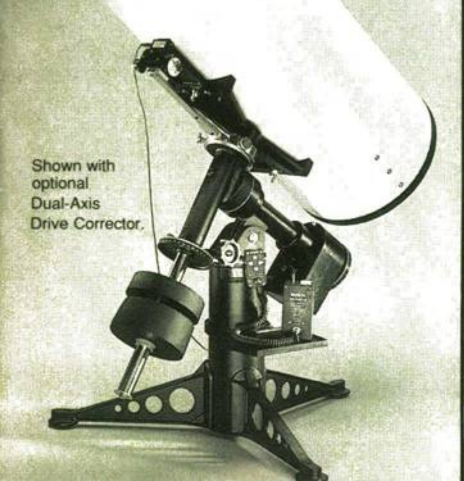
6" f/8
$569.95

8" f/6
$649.95

10" f/4.5
$759.95

Starfinder 16: 16" f/4.5 $1995.

See the Meade General Catalog for details.



Shown with optional Dual-Axis Drive Corrector.

STARFINDER™
REFLECTING TELESCOPES

Meade Starfinder 6", 8", and 10" reflecting telescopes offer the finest values available anywhere. **Standard equipment on all 3 models includes:**

■ **Superb Optical System:** Includes a Meade hand-figured parabolic primary mirror that meets the theoretical limit of resolution for its aperture, with matching elliptical flat secondary mirror. Both mirrors multi-coated and made of fine-annealed Pyrex® glass.

■ **Precision Equatorial Mount:** Manufactured of virgin aluminum castings machined to tolerances of .001" or better, and placed atop a 4"-dia. pier with die-cast tripod legs, yielding rock-solid support for the optical tube assembly. The telescope moves effortlessly from object-to-object on precision bearing surfaces. Polar and declination shafts are 1" solid steel. Setting circles on both axes facilitate the location of faint sky objects directly from their catalogued coordinates.

■ **Electric Motor Drive** (115v./60Hz) with 6 ft. power cord: Permits fully automatic tracking of celestial objects; plugs into any standard outlet.

■ **Accessories and Components:** Meade Starfinder telescopes include high-performance components throughout: **#71 Rack-and-Pinion Focuser** (1.25") for smooth, backlash-free focusing of the image; a coated achromatic **#637 6 x 30mm Viewfinder** with crosshair eyepiece and 7° field, for quick object-locating; **coated MA 25mm** (1.25") eyepiece; strong, durable spiral-wound **optical tube** with attractive white finish; and **cast aluminum mirror cell** for accurate mounting and alignment of the primary mirror.

■ **Optional Accessories:** See the opposite page for some of the many optional accessories available. Additional systems, including the **#55 Manual Declination Control**, **#43 Drive Corrector** and **#47M Dual-Axis Drive Corrector,** are described in the **Meade General Catalog.**

A Meade Starfinder telescope opens up the skies to an extremely wide range of serious visual observing, to lunar and planetary photography, and even to limited deep-space photography. And every telescope is backed by the World's largest manufacturer of serious telescopes.

■ **Packing & UPS Shipping Charges to any address in the 48 states: 6"--$50; 8"--$60; 10"--$75.**

■ Prices shown are suggested USA mail-order retail prices, not including any applicable sales taxes.

■ **The 1992 Meade General Catalog—$3.00 postpaid—is available from any authorized Meade dealer or directly from Meade Instruments.**

■ **For further information call Meade Instruments toll-free at 1-800-854-7485 (in Calif. 714-556-2291) or contact one of these authorized mail-order dealers:**

ASTRONOMICS, Norman, OK.
Orders: 800-422-7876; Info.: 405-364-0858.

CALIFORNIA TELESCOPE COMPANY, Burbank, CA.
Orders: 800-843-4780; Info.: 818-505-8424.

FOCUS CAMERA, Brooklyn, NY.
Orders: 800-221-0828. Info.: 718-436-6262.

LUMICON, Livermore, CA.
Orders: 800-767-9576; Info.: 510-447-9570.

SCOPE CITY/Mail-Order Dept., Simi Valley, CA.
Orders: 800-235-3344; Calif. and Info.: 805-522-6701.

SHUTAN CAMERA & VIDEO, Chicago, IL.
Orders: 800-621-2248; Illinois & Info.: 312-332-2000.

Canada:

KHAN SCOPE CENTRE, Toronto, Ontario.
Orders and Information: 416-783-4140.

ADVANCED PRODUCTS DIVISION **Meade Instruments Corporation**

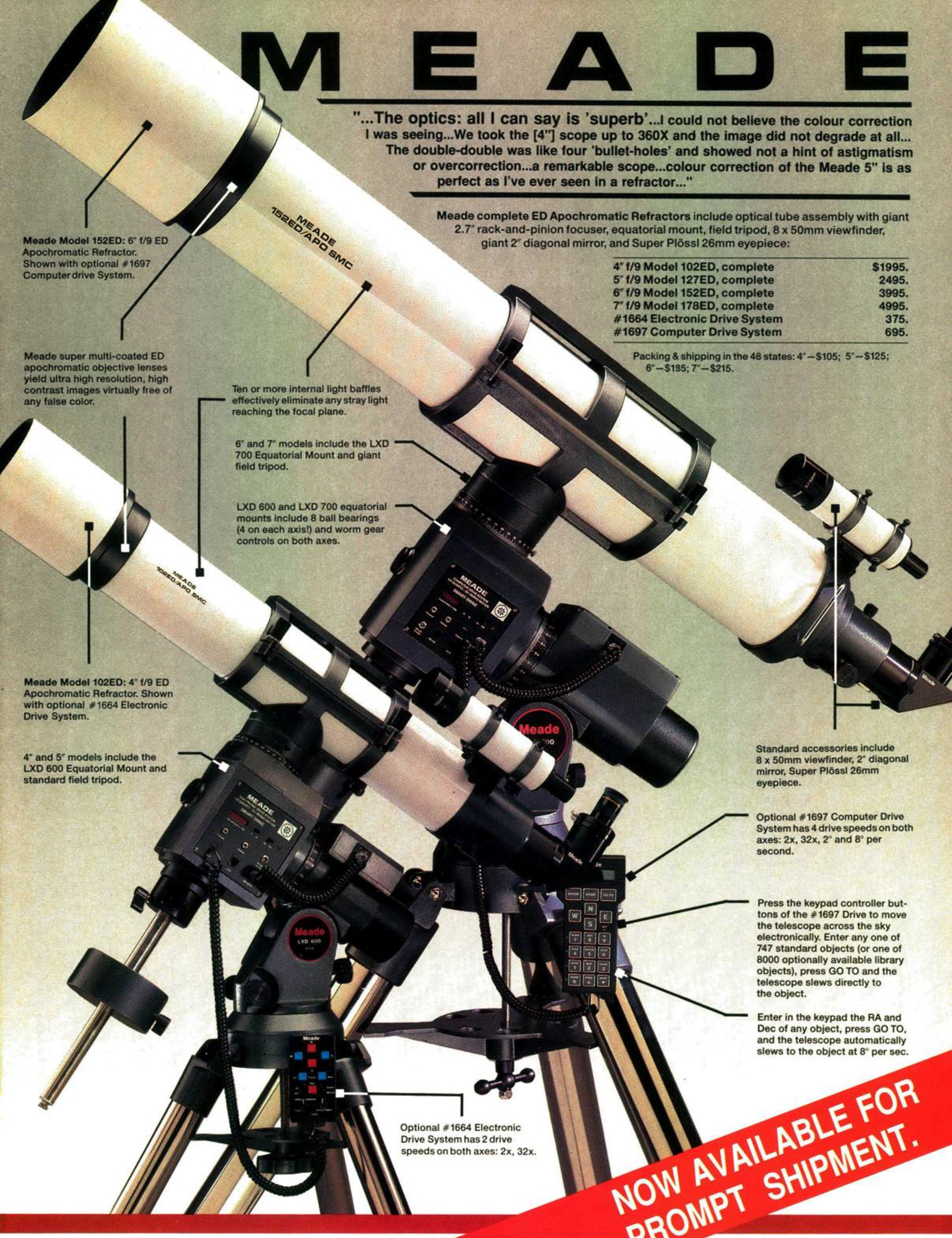
MEADE

"...The optics: all I can say is 'superb'...I could not believe the colour correction I was seeing...We took the [4"] scope up to 360X and the image did not degrade at all... The double-double was like four 'bullet-holes' and showed not a hint of astigmatism or overcorrection...a remarkable scope...colour correction of the Meade 5" is as perfect as I've ever seen in a refractor..."

Meade complete ED Apochromatic Refractors include optical tube assembly with giant 2.7" rack-and-pinion focuser, equatorial mount, field tripod, 8 x 50mm viewfinder, giant 2" diagonal mirror, and Super Plössl 26mm eyepiece:

4" f/9 Model 102ED, complete	**$1995.**
5" f/9 Model 127ED, complete	**2495.**
6" f/9 Model 152ED, complete	**3995.**
7" f/9 Model 178ED, complete	**4995.**
#1664 Electronic Drive System	**375.**
#1697 Computer Drive System	**695.**

Packing & shipping in the 48 states: 4"—$105; 5"—$125; 6"—$195; 7"—$215.



Meade Model 152ED: 6" f/9 ED Apochromatic Refractor. Shown with optional #1697 Computer drive System.

Meade super multi-coated ED apochromatic objective lenses yield ultra high resolution, high contrast images virtually free of any false color.

Ten or more internal light baffles effectively eliminate any stray light reaching the focal plane.

6" and 7" models include the LXD 700 Equatorial Mount and giant field tripod.

LXD 600 and LXD 700 equatorial mounts include 8 ball bearings (4 on each axis!) and worm gear controls on both axes.

Meade Model 102ED: 4" f/9 ED Apochromatic Refractor. Shown with optional #1664 Electronic Drive System.

4" and 5" models include the LXD 600 Equatorial Mount and standard field tripod.

Standard accessories include 8 x 50mm viewfinder, 2" diagonal mirror, Super Plössl 26mm eyepiece.

Optional #1697 Computer Drive System has 4 drive speeds on both axes: 2x, 32x, 2° and 8° per second.

Press the keypad controller buttons of the #1697 Drive to move the telescope across the sky electronically. Enter any one of 747 standard objects (or one of 8000 optionally available library objects), press GO TO and the telescope slews directly to the object.

Enter in the keypad the RA and Dec of any object, press GO TO, and the telescope automatically slews to the object at 8° per sec.

Optional #1664 Electronic Drive System has 2 drive speeds on both axes: 2x, 32x.

NOW AVAILABLE FOR PROMPT SHIPMENT.

METEORITES
Buy•Sell•Trade
ROBERT A. HAAG METEORITES
Send $5.00 for your 64 page, full-color, brand-NEW Field Guide of Meteorites. Cost refundable with first purchase. Authenticity 100% *guaranteed.*
P.O. Box 27527, Tucson, AZ USA 85726, (602) 882-8804

**Star Hill Inn
an astronomer's retreat
in the Rockies**
Come for a dark sky vacation...bring your 'scope or rent one of ours! Comfortable accommodations at our beautiful 7200' elevation. Wonderful daytime activities in nearby Santa Fe, Taos, and Pecos Wilderness. Open year-round.
For free information:
**Star Hill Inn, Sapello, New Mexico, 87745
(505) 425-5605**

METEORITES
**Nickel\Irons - Mesosiderites
Chondrites - Pallasites - SNC's**
For a list of available specimens and educational materials or information on our meteorite preservation, repair, etching and appraisal services, please write, call or fax:
**New England
Meteoritical Services**
P.O. Box 440-A, Mendon, MA 01756 USA
Tele 508-478-4020 FAX 508-478-5104

**ASTRONOMY CAMPS
FOR ADULTS
AND STUDENTS**
The University of Arizona in Tucson, Arizona —*"The Astronomy Capital of the World"*— is proud to continue its award-winning astronomy camps for teenagers and adults.
Activities include:
✱ Lectures by astronomers on topics from the solar system to cosmology ✱ Viewing, photography, spectroscopy and CCD imaging of celestial objects through 40", 60" and 61" telescopes on Mount Lemmon
✱ Tour of Mirror Laboratory
✱ Application of computer and engineering technologies.
Camp Dates
Adults: April 23-25
Teens (Basic): June 7-14
Teens (Advanced): June 18-25
Cost
Adults: $300
Teens: $485
To register:
Call Lisa Roubal at 1-800--232-8278
(In Arizona: 602-621-5233)
THE UNIVERSITY OF ARIZONA ALUMNI ASSOCIATION

expropriate, subjugate, and destroy? First the "new worlds" of continents beyond Europe. Now the whole of planet Earth. Tomorrow will it be Mars?

Which is the essence of human nature, to explore and learn or invade and kill? The hallmark of a civilized society is a respect for other things. We cannot transform every place we encounter to suit our own needs. The pristine deserts on Mars should be left alone. So what if other life forms are out there? We should leave them alone, too. — *Ted Aranda, Chicago, Illinois*

Here's the Real Illusion

Ken Croswell's article "The Grand Illusion" (November 1992) was a most enjoyable read. After I compared the radio and visible images of the Whirlpool Galaxy (M51), I noticed that the "light blue" round object 12 mm to the right of the double green and red blob has no visible counterpart. I can't see a star, HII region, or nebula that could be the source of this "blue" object. What could it be? — *Alister Ling, Edmonton, Alberta, Canada*

We don't know — any readers care to venture a guess?

Hubble Appeal

During 1993 I'll have the good fortune to use the Hubble Space Telescope (HST) to study three asteroids as part of the HST Amateur Observing Program. I am looking for backyard astronomers who would be willing to observe these asteroids from the ground while HST is taking data on them from space.

The magnitudes of the asteroids will range from 11.4 to 15.1. Both visual and photographic observations are needed. For more information, please contact me: Harald Schenck, 2330 South 11th Street, Sheboygan, WI 53081

Chasing Double Stars

Thank you for publishing "Autumn's Colorful Double Stars" by Mark T. Stauffer (November 1992). I was delighted to see an article on doubles tailor-made for small-scope owners wishing to observe relatively bright pairs. Having just received my Messier certificate from the Astronomical League, I'm getting back into double star observing and was greatly helped by this article. The only thing that bothers me is that neither photos nor sketches can really do justice to the gemlike quality of double stars. Please keep publishing articles like this one. — *Alan Pasicznyk, Doylestown, Pennsylvania*

One-Hour Astrophotos

Two years ago I took my first steps into the world of astrophotography. A short time later, much to my delight, a one-hour photo lab opened less than a mile from my home. Until then, I had been taking my film to a similar shop about 25 miles away. At first astrophotography was tricky and the results were sometimes disappointing. I found that investing a little time in the developing could pay off, however. The technician at the new lab was helpful and quickly developed a great eye for just the right density and color balance when processing what were to her unusual negatives. All it took was a few batches of film spread over several weeks and a little friendly consultation each time I visited the shop.

The discovery of a one-hour photo lab I can work with — and the helpful nature of my relationship with the people who work there — has made astrophotography a real pleasure. Who ever said that taking pictures of sky objects had to be a messy, painful, frustrating experience? All it takes is a little communication. — *Frank W. Hitchens, Shelburne County, Nova Scotia, Canada*

Success with Observing Method

I attempted to replicate Dean Grantham's observing methods ("An Observational Breakthrough for Astronomers," January 1993), and it was incredible. I swept through hundreds of deep-sky objects with my 2.4-inch refractor. Sharpless 106 and 109 in the Cygnus Nebular Complex were breathtaking. And the star-studded globulars G78 and G213 in the Andromeda Galaxy were beyond belief. The spectacles kept coming as I had never seen them before. Bright and faint objects appeared equally impressive.

However, as I was viewing an exotic galaxy, Maffei I, the object began to slip out of the field of view. I was shocked at first, but I looked up from my scope and saw my neighbor's garage door moving slowly upward. And my neighbor driving his car into his garage.

Although Grantham inferred that neither lunar nor solar cycles would cause any observing inconvenience, nothing was said about problems relating to electrical interference. — *Patrick J. Thibault, Willmar, Minnesota* ☐

ASTRONOMY welcomes suggestions and additional information about articles and astronomy in general. Send your letters to ASTRONOMY Letters, P.O. Box 1612, Waukesha, WI 53187. Letters may be edited for length and clarity.

TWO HOURS WITH STEPHEN HAWKING

by Russ Sampson

He has been called a science superstar, the successor to Albert Einstein, even Master of the Universe. Stephen Hawking is certainly one of the most famous scientists in the world today. Recently, I and a number of other area reporters had the opportunity to spend two hours questioning Hawking on matters ranging from the birth and death of the universe to the rights of the disabled.

The occasion was Hawking's visit to deliver a public lecture at the University of Alberta in Edmonton on the future of the universe. Hawking is now in the advanced stages of amyotrophic lateral sclerosis (ALS) or Lou Gehrig's disease and is confined to a motorized wheelchair and unable to speak. His public lecture was programmed and delivered through his computerized voice synthesizer while an assistant changed the overhead transparencies.

At the lecture, the auditorium was filled to capacity with 3,000 enthusiasts, scientists, and VIPs. University president Paul Davenport said they could have sold at least 10,000 more seats. One professor received a frantic phone call from an individual prepared to pay $100 for a single ticket. Fortunately, the pre-lecture press conference was a much smaller affair. It was a little like being granted an audience with the Dalai Lama — for two hours we were hanging on Hawking's every word, hoping to learn the secrets of the universe.

Hawking, the Lucasian Professor of Mathematics at Cambridge University in England (a post once held by Isaac Newton), is best known for his work on the nature of black holes and the origin and ultimate fate of our universe. In the early 1980s Hawking formulated his now famous "no-boundary proposal," one of the first attempts at unifying the two fundamental theories of physics: quantum mechanics and general relativity. By applying these theories to the study of cosmology, Hawking suggested the universe may be completely self-contained, having no boundary or edge and no beginning or end. In Hawking's own words the universe "would simply BE."

One of the predictions made by the no-boundary proposal said that the early universe should be slightly irregular. This lumpiness would show up as ripples in the cosmic microwave background radiation formed when the universe was only 300,000 years old. These ripples would also be necessary to explain the eventual formation of galaxies and clusters of galaxies.

At the press conference each reporter was allowed to ask one question of Hawking. Mine stemmed from the recent discovery by NASA's Cosmic Background Explorer (COBE) of minute irregularities in the microwave background radiation. Did these confirm his "no-boundary proposal," I asked. Hawking replied, "The recent observations agree exactly with the predictions of the no-boundary proposal. They could easily have disagreed with it. They don't prove the no-boundary proposal, but the proposal is looking pretty good."

We were hanging on Hawking's every word, hoping to learn the secrets of the universe.

I had my answer from one of the great minds of our time. But was it right? Don Page, a cosmologist at the University of Alberta who studied under Hawking, disagrees with his mentor's optimism. Page believes that the evidence from COBE is not conclusive enough to support the no-boundary proposal.

Someone asked what future scientific evidence Hawking was most curious to see. Hawking replied, "I am interested in seeing further observations of the cosmic background radiation and results from LIGO, which will be looking for gravitational waves from collisions of black holes and neutron stars. I think we may get very surprising results."

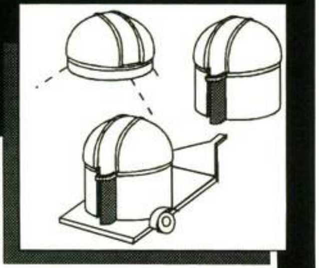
LIGO (the Laser Interferometer Gravitational Wave Observatory) is a project to build two huge gravity wave detectors. According to Einstein's theory of general relativity, massive objects in motion, like colliding black holes and

KITES
FREE COLOR CATALOG
Choose from over 200 exciting kites.
• Many unusual & innovative designs.
Call or write for your catalog today!
Into The Wind • (800) 541-0314
1408-A Pearl St., Boulder, CO 80302

METEORITES!
Irons. Stones. Stony-irons. Tektites.
Quality display and study specimens.
Space jewelry, books, slides.
Authenticity guaranteed.
Color Catalog $2.
Bethany Sciences
P.O. Box 3726-A
New Haven, CT 06525
CATCH A FALLING STAR!
(203)393-3395

3" VIEWFINDER

$49.95
Complete
LIMITED QUANTITIES
add $5 S&H US – diagonal & eyepiece not included
3" f/4.5 Multi-Coated Achromatic Objective
mounted in machined aluminum cell with 1 1/4" helical-lock focusing & extension tube for straight-through viewing. Plans for easy-to-make collimating mounts included. Sound too good to be true? It will be when they're gone! Order early – WHILE SUPPLY LASTS.
1-719-495-3828
CREDIT CARD ORDERS
BLACK FOREST OBSERVATORY
Department AS2
12815 Porcupine Lane
Colorado Springs, CO 80908

HOME-DOME
THREE NEW 6' MODELS...
MORE AFFORDABLE THAN EVER

• On-Structure(46"h)
• Stand-Alone(82"h)
• Roam-Dome(82"h)
All Domes Feature
• Easy Assembly
• All Fiberglass
• Complete Systems
6' - $1950 up
10' - $3750 up
Technical Innovations, Inc.
22500 Old Hundred Road
Barnesville, MD 20838
301-972-8040
FREE Brochure

NEW MEADE® ADVANCED PRODUCTS AT LUMICON

"What an astounding combination of high performance and low price!" Jack Marling, Ph.D., owner of LUMICON

TOLL-FREE ORDER LINE 1-800-767-9576 EXPERT INFORMATION 1-510-447-9570 FAX 1-510-447-9589

MEADE APOCHROMAT ED REFRACTORS

6" f/9 Apochromat Only $3995

Meade 6" f/9 Model 152ED Refractor shown with #1697 Computer.

See the Meade ad in this magazine for full specifications and product descriptions. ED = Extremely low dispersion glass which yields color-free virtually perfect images. PPEC = Permanent Periodic Error Correction "Smart Drive."

Model 102 ED 4" f/9 Apochromat & mount (add $105 P&S)	**$1995**
Model 127 ED 5" f/9 Apochromat & mount (add $125 P&S)	**$2495**
Model 152 ED 6" f/9 Apochromat & mount (add $185 P&S)	**$3995**
Model 178 ED 7" f/9 Apochromat & mount (add $215 P&S)	**$4995**

DRIVE SYSTEMS

#1664 Electronic Drive with PPEC and 2X, 32X slewing system, dual-axis controller	**$375**
#1697 Computer Drive, 747 object computer memory, automatic slewing to desired object	**$695**
8,000 Object CNGC Library	**$99**
Polar alignment finder	**$99**

OPTICAL TUBE ASSEMBLIES (OTA)

Model 102 ED/OTA 4" f/9 OTA only	**$1075**
Model 127 ED/APO-OTA 5" f/9 OTA only	**$1595**
Model 152 ED/APO-OTA 6" f/9 OTA only	**$2295**
Model 178 ED/APO-OTA 7" f/9 OTA only	**$2995**

EQUATORIAL MOUNTS

LXD 600 mount and standard field tripod (add $50 P&S)	**$1050**
LXD 700 mount and giant field tripod (add $125 P&S)	**$1995**

NOTE: Add the indicated packing and shipping (P&S) costs to each telescope for insured UPS shipment to your door.

MEADE SERIES 4000 PREMIUM EYEPIECES

6.4, 9.4, 12.4, 15, 20, 26mm Plossl	**$88**
32mm, 40mm Super Plossl	**$110**
13.8mm Super Wide Angle	**$140**
18mm Super Wide Angle	**$150**
24.5mm Super Wide Angle	**$170**
32mm Super Wide Angle (2")	**$240**
40mm Super Wide Angle (2")	**$299**
4.7mm Ultra Wide Angle	**$155**
6.7mm Ultra Wide Angle	**$198**
8.8mm Ultra Wide Angle (1¼/2")	**$230**
14mm Ultra Wide Angle (1¼/2")	**$270**

Shipping charges of 1-2% are extra.

MEADE LX100 & LX200 SCHMIDT-CASSEGRAINS

8" LX200 $2195

NEW Meade 8" LX200 Telescopes

See the Meade ad in this magazine for full specifications & details. **LX100 Drive**, 2X, 32X speed control with PPEC (Permanent Periodic Error Correction "Smart Drive") & dual-axis hand controller. **LX200 Drive,** Full electronic control with PPEC, 747 object computer memory and automatic computer controlled slewing to desired object. *NOTE:* A wedge is **not** needed for visual observing with the LX200 Drive.

8" LX100 Schmidt-Cassegrain with wedge (add $105 P&S)	**$1795**
8" LX200 Schmidt-Cassegrain with computer (add $105 P&S)	**$2195**
Wedge for photographing with 8" LX200	**$110**
10" LX100 Schmidt-Cassegrain w/super wedge (add $145 P&S)	**$2595**
10" LX200 Schmidt-Cassegrain with computer (add $145 P&S)	**$2495**
Super Wedge for photography with 10" LX200	**$395**
8,000 Object CNGC Library	**$99**

OTHER SCHMIDT-CASSEGRAINS

NEW! **SSC-8**, 8" Schmidt-Cass on LXD-600 mount (add $105 P&S)	**$1395**
NEW! **SSC-10**, 10" Schmidt-Cass on LXD-600 mount (add $125 P&S)	**$1695**
NEW! **SSC-12**, 12" Schmidt Cass on LXD-700 mount (add $195 P&S)	**$3495**
NEW! **SSC-14**, 14" Schmidt-Cass on LXD-700 mount (add $245 P&S)	**$4795**
Meade 2045D 4" f/10 with motor drive (add $40 P&S)	**$599**
Meade 2080B 8" f/10 with tripod, wedge, MCOG (add $85 P&S)	**$1149**
NEW! Model 2120B 10" f/10 w/wedge, tripod, MCOG (add $125)	**$1449**

PHOTOGRAPHY ACCESSORIES

LUMICON Cassegrain EASY-GUIDER f/6 or f/10	**$225**
LUMICON Giant EASY-GUIDER for 10" f/5-f/10 operation	**$395**

MEADE STARFINDERS

8" f/6 $649*

New 8" f/6 Meade Starfinder telescopes

See the Meade ad in this magazine for full descriptions and technical specifications for 6" to 16" Starfinders. These are complete telescope systems with motor drive, mount, finderscope and 25mm (=48X) eyepiece.

6" f/8 Starfinder 6(add $50 P&S)	**$569**
8" f/6 Starfinder 8 (add $60 P&S)	**$649**
10" f/4.5 Starfinder 10 (add $75 P&S)	**$759**
16" f/4.5 Starfinder 16 (ship. freight COD)	**$1995**

*All Starfinder telescopes shipped directly from Meade to the purchaser. Please add the indicated shipping charge to the price. LUMICON showroom prices are $96 higher.

ACCESSORIES

LUMICON carries the full line of Meade accessories. See the Meade ad in this magazine for detailed prices and descriptions.

Meade #43 Single axis drive corrector	**$99**
LUMICON DX200 Dual-axis drive cor.	**$249**
Meade 47M Dual-axis drive corrector	**$399**
LUMICON DX2BP Dual-axis drive corrector with built-in battery pack	**$299**

LUMICON® SKY VECTOR™

Higher Performance — Lower Price

LUMICON ACCESSORIES

LUMICON, 2111 Research Dr., #5, Livermore, CA 94550 (510) 447-9570 FAX (510) 447-9589

LOW PRICE—from $399

LUMICON SKY VECTOR FEATURES:

- "GUIDE" mode leads you to object
- Digital right ascension readout to 1 min.
- Digital decl. readout to 10 arc-min.
- 4000 pulse (0.09° accuracy) encoders
- Polar alignment ***not required!***
- Motor drive ***not required!***
- Just sight two stars to align!
- Works **equally well** for alt-azimuth telescopes like Coulter Odyssey and equatorial mounts like C-8, Meade 2080.
- **No need** to enter latitude, longitude, etc.

SKY VECTOR I™ $399

NEW! With over 220 object memory including the 110 Messier and 58 best NGC objects.

SKY VECTOR II™ $499

IMPROVED — Planets, Over 3,700 Objects! With size, magnitude and full visual description.

NGC SKY VECTOR™ $699

IMPROVED!—5500 Additions / Corrections

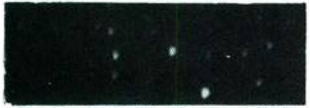
NGC-Sky Vector
OFF ON
DIM
MODE
ENTER
UP
DOWN
LUMICON

Improved NGC SKY VECTOR with over 12,000 object memory including complete, corrected RNGC catalogue, IC catalogue, complete P&K planetary catalogue, and much more!

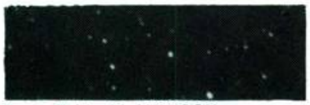
Specify Telescope Type: Meade 2045, 2080, 2120, C-8, C-11, Odyssey 8, 10, 13, 17½, Alt-Azimuth.

Ultima 8, 11 .. **add $25**, C-14 .. **add $75**

COMA CORRECTOR



Coma 1 inch off-axis 17½" f/4.5



Same field with LUMICON coma corrector; smaller, more numerous stars.

This computer-designed LUMICON 2" lens reduces coma and flattens the field for both viewing and photography. **It threads into LUMICON 2" EASY-GUIDERS for effortless installation.** This zero power lens does not change image scale nor shift focus, and all lens surfaces are multi-coated for highest efficiency. Clear aperture = 1.8".

LUMICON 48mm Coma Corrector/Field Flattener Lens	**$285.00**
LUMICON 2" EASY-GUIDER	**$169.50**
2" EASY-GUIDER (Mamiya 645)	**$199.50**
2" Adapter for Pentax 6x7	**$129.00**
2" Adapter for Hasselblad	**$229.00**
2" Adapter for Bronica SQ-A	**$175.00**
2" Extension for viewing	**$26.00**

2" DELUXE BARLOW

1.8x Multiplier Lens (2" Barlow)

LUMICON 1.8x Multiplier Lens (2" Barlow)	**$235.00**

LARGE UV/DUST SEAL

Protect the optics of your 8-14" Schmidt-Cassegrain with a UV/Dust Seal. Simply thread it onto the rear cell, then attach all normal accessories. The large size fits Meade 2120, Celestron-11 and -14 & has a high quality multi coated (removable) 72mm UV filter.

Deep-Sky Filter/Dust Seal for C-8, 2080	**$119.50**
UV/Dust Deal for Celestron C-8	**$39.00**
UV/Dust Seal for Meade 2080, 2045	**$39.00**
UV/Dust Seal (large) for Meade 2120	**$89.50**
UV/Dust Seal for Celestron-11, -14	**$89.50**

NEW! LOW PROFILE HELICAL FOCUSERS

FROM $59.50

LUMICON® LOW PROFILE FOCUSERS

LUMICON now offers 3 different low-profile helical focusers. They stand only 1¼-1½" above the telescope tube. Use the 1¼" or 2" versions for viewing. Use the 2" non-rotating focuser for convenient photography with the LUMICON 2" EASY-GUIDER™.

Select your desired base-plate shape! Flat, 7" OD, 9½" OD, 12½" OD, 16" OD, 21" OD.

LUMICON 1¼" Helical Focuser	**$59.50**
LUMICON 2" Helical Focuser 1½" high	**$65.00**
LUMICON Non-rotating Helical Focuser	**$129.00**
2" rack & pinion focuser, only 2" high	**$139.00**
3 handles for non-rotating focuser	**$12.95**
2"/1¼" adapter w/48mm filter threads	**$20.00**
2" LUMICON EASY-GUIDER	**$169.50**

LUMICON 50mm, 80mm SUPER-FINDER™

Visual Astronomers prefer the LUMICON 80mm SUPER-FINDER™, since hundreds of deep-sky objects, including most Messier objects, are visible directly. SUPER-FINDERS also make nice small portable telescopes. 80mm aperture, F=300mm coated achromat or 50mm, F=200mm coated achromat. Eyepieces and/or star diagonal are extra.

1¼" 50mm Finderscope **$59.50**, right-angle	**$59.50**
1¼" straight-thru 80mm SUPER-FINDER	**$169**
1¼" right-angle 80mm SUPER-FINDER	**$179.50**
1¼" right-angle version, w/star diagonal	**$209**
25mm Cross-hair 1¼" eyepiece (12X)	**$39**
Large mounting rings for 80mm Finder	**$55**
1¼" Star Diagonal **$39**, Mounting Brackets,	**$39.50**
1¼" 45° diagonal for correct left-right views	**$52.44**

LOTS OF ADAPTERS

2" adapter for C-8, Meade 2080, etc.	**$26.00**
2" adapter for C-80, C-100 refractor	**$39.50**
2" adapter for C-70, C-80F, C-100F fluorite	**$39.50**
2" adapter for C-6, Comet Catcher, Meade 312	**$30.00**

EXTENSION TUBES

1" long 1¼" OD thread-in extension	**12.00**
2½" long extension (holds 1¼" filters)	**16.00**
4½" long extension for 1¼" eyepieces	**$25.00**
3" long extension for 2" eyepieces*	**$26.00**
2" long extension for 2" eyepieces*	**$26.00**

VIEWING ADAPTERS

2"/1¼" reducing bushing,threaded 48mm*	**$20.00**
2"/T-thread adapter, threaded 48mm*	**$25.00**
T-thread/1¼" adapter	**$25.00**
F/10 2" or 1¼" eyepiece viewing adapter for Giant Easy-Guider	**$39.50**
Low profile star diagonal eyepiece holder	**$16.00**
Meade 2" Diagonal/Giant Easy-Guider	**$39.50**

**Threaded to hold 48mm filters.*

Meade & Celestron
LUMICON carries a full line of telescopes & accessories. Fast delivery, competitive prices.

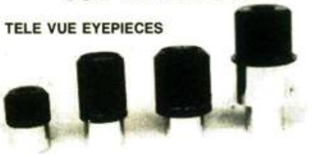
LUMICON FOR HIGH PERFORMANCE

ASTROPHOTO OF THE MONTH

NGC 2264 "The Cone Nebula" in Monoceros. 70 minute photo by Eraldo Guidolin (in Italy) using an 8" f/10 telescope, a LUMICON Cassegrain Easy-Guider at f/6 and hypered 2415 film with a LUMICON Deep-Sky Filter. Mr. Guidolin stated, " . . . Congratulations for your good service and the high quality of your products. With your guider I have taken hundreds of high quality photographs, perfectly guided."

TELE VUE™
USE THE BEST!

TELE VUE EYEPIECES



Genesis 4" f/5 4 element fluorite	$1595
Pronto 70mm f/6.4 apochromat w/2" diagonal	$698
Pronto 70mm f/6.4 w/Porro prism	$649
Complete Equatorial Mount	$795
Motor Drive for above mount	$198
7.4, 10.4, 13, 17, 21, 26mm Plossl 50°	$89
1.8x or 2.5x Tele Vue Barlow Lens	$89
2" Giant Barlow - 2x	$189
32mm Plossl, widest true field in 1¼"	$109
55mm 2" Plossl, widest possible field	$219
15mm Wide-Field, 1¼" eyepiece, 65°	$135
19mm Wide-Field, 1¼" eyepiece, 65°	$145
24mm Wide-Field, "superb," 65°	$169
32mm Wide-Field, 2" eyepiece, 65°	$239
40mm Wide-Field, "awesome," 65°	$299
4.8mm Nagler, 82° field	$149
7mm Nagler, 1¼" eyepiece, 82° field	$189
9mm Nagler, 82° field, "the best"	$219
11mm Nagler, 82° field, 1¼" or 2"	$235
13mm Nagler, 82° field, 1¼" or 2"	$249
12mm Nagler, Type II, 82°, 1¼"/2"	$249
16mm Nagler, Type II, 82°, 1¼"/2"	$289
20mm Nagler, Type II, 82°, 2" only	$340
1¼" Paracorr Visual Coma Corrector	$159
2" Paracorr Visual Coma Corrector	$249
NEW! 22mm Panoptic 1¼"/2", 68°	$249
NEW! 35mm Panoptic 2", 68° field	$325

ADJUSTABLE PIGGYBACK MOUNT

The LUMICON adjustable piggyback mount is ideal for telescopes of 6-16" aperture. It permits **both** vertical and sideways adjustment for optical alignment. Also ideal to mount LUMICON 80mm SUPER-FINDER™, large telephoto lenses and small telescopes up to about 5 lbs.

LUMICON Adjust. Piggyback Mount $59.50
Specify telescope size: 6", 8", 10", 11", 14", 16"

H-ALPHA PASS FILTER

Yields spectacular contrast gains in B&W photograph with telephoto lenses. Yields pinpoint star images. Superb with hypered 2415. For color, use the Minus Violet (MV) Filter.

Specify Lens Size	**H-Alpha**	**(MV)**
46, 48, 49mm	$49.00	$39.00
52, 55, 58, 62mm	$59.00	$49.00
67, 72, 77mm	$69.00	$59.00
82mm	$79.00	N/A

Hypered 2415 film, 36 exp .. **$10.95, $3/$29**

LUMICON®

2111 Research Dr. #5A, Livermore, CA 94550
For phone orders please call (510) 447-9570
FAX (6 PM-9 AM PST) (510) 447-9589
LUMICON Products catalogue FREE
All foreign orders add 8% ($10 minimum)
California residents add 8.25% tax.
Prices subject to change w/o notice.
Hrs: M-F 9 am - 5 pm, Sat. 11 am - 3 pm

NEW! ENHANCED ALUMINUM DIAGONAL MIRRORS BOOST TELESCOPE PERFORMANCE

LUMICON 1.3" & 2.1" enhanced aluminum diagonal mirrors & 1¼" star diagonal.

The new LUMICON diagonal mirrors have a special enhanced aluminum coating with a protective overcoating for long life. Visible reflectivity is 94-96% compared to 86-89% for standard aluminum coated mirrors. The extra 5-10% transmission is like adding up to an inch of aperture! The substrate is fine annealed Pyrex flat to 1/8 wave.

1.32"	**$35.00**	1.52"	**$39.00**	1.83"	**$45.00**
2.14"	**$59.50**	2.60"	**$75.00**	3.10"	**$99.50**

ENHANCED ALUMINUM STAR DIAGONAL

90° star diagonals with 96% reflectivity enhanced aluminum mirrors in a CNC machined black anodized aluminum body. Performance far exceeds prism diagonals.

1¼" (1.32" mirror)	**$99.50**
2" (1.83" mirror)(see photo above)	**$159.00**

LUMICON FILTERS — BEST IN THE WORLD!

"The LUMICON OIII proved to be our favorite... It gave the greatest contrast gain."
ASTRONOMY February 1991

AMAZING OIII FILTER™

Helix Nebula, NGC 7293 in Aquarius. Bright and easy with Lumicon Oxygen-III Filter.

The ultimate in filter performance! The Lumicon Oxygen-III Filter has a contrast twice as high as the high performance Lumicon UHC Filter™. Use the Oxygen-III Filter for observing the very faintest planetary and diffuse emission nebulae. Also gives incredible views of bright nebulae (like M-27, M-17, etc.) from urban locations. Bandpass is 11nm, transmission is 90-96% for both O-III lines at 496nm and 501nm.

SEE THE HORSEHEAD!

Horsehead Nebula in Orion. This faint nebula is seen best with a LUMICON H-Beta Filter. Photo by J. Marling using a Deep-Sky Filter.

"I CAN SEE THE VEIL NEBULA!"

Rich Zepernick saw the Veil Nebula for the very first time with a **LUMICON UHC Filter**. He stated, *"It was actually there! and not just around 52 Cygni, but the whole loop! Words cannot possibly express my feelings. I don't know how I managed without these filters."*
Rich Zepernick, Cresskill, NJ

DEEP-SKY FILTER™
BEST for Astrophotography!

"Stunning is all I can say," says noted astrophotographer Jack Newton. Great for BOTH color and black and white photography.

BEST WIDE-BAND FILTER!

"Based on our tests we'd recommend a LUMICON Deep-Sky and Oxygen-III as complementary filters. The LUMICON Deep-Sky Filter clearly had the best contrast for ***reflection*** *nebulae."*
Astronomy, Feb. 1991

	Premium*
0.96" LUMICON DEEP-SKY Filter threads into most 0.96" eyepieces	$59.50
1¼" LUMICON DEEP-SKY Filter threads into most 1¼" eyepieces	$79.50
48mm LUMICON DEEP-SKY Filter (1.7" aperture), threads into most 2" eyepieces. Also fits LUMICON EASY-GUIDERS	$119.50
2" LUMICON DEEP-SKY Filter (1.5" aperture), threads into most 2" eyepieces. Also has male & female camera T-threads for prime focus photography	$119.50
72mm LUMICON Giant DEEP-SKY Filter (62, 67, 77mm adapter, $8)	$299.50
2" Rear Cell Filter, fits SCT's ... Deep-Sky, **$119.50** UHC, O-III, H-Beta,	$199.50
1¼" LUMICON UHC Filter threads into most 1¼" eyepieces	$99.50
48mm LUMICON UHC Filter (1.75" aperture) fits most 2" eyepieces	$199.50
Set of both premium **DEEP-SKY** and **UHC Filters** (Save 11%) ... 1¼" **$159.50**; 48mm	$279.50
LUMICON H-BETA Line Filter (9mm bandpass at 486nm). For the California Nebula, Horsehead Nebula, and other extremely faint nebulae. **1¼" ... $99.50, 48mm**	$199.50
Oxygen-III Filter for very faint planetary and diffuse nebulae, 11nm bandpass at 496nm and 501nm O-III lines ... **1¼" $99.50, 48mm**	$199.50
Telephoto lens adapter for 2" or 48mm filter. Select 46, 49, 52, 55, 58mm	$6.95
Universal adapter for 1¼" filters. Adapts the 1¼" filters to any 1¼" eyepiece	$16.00
Universal adapter for 48mm or 2" filters. Allows use of any 1¼" eyepiece	$20.00

**Premium filters are currently the best in the world. All Lumicon filters include individually measured transmission data.*

DEEP-SKY ASTROPHOTOGRAPHY

SR-V 3200 NEW FILM

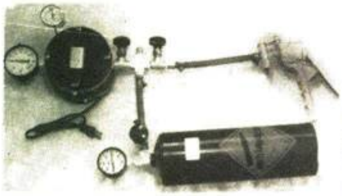
FILM HYPERSENSITIZATION KITS†

LUMICON HYPER-KITS™ yield 3-15x film speed gain in long exposures. They are safe & simple to use. Easy HYPER-KIT includes a chamber with all controls and fittings, thermometer, a refillable cylinder of non-flammable forming gas & hand-operated vacuum pump.

U.S. Patent 4,473,636

MAKE YOUR OWN HYPERED FILM

MODEL 300 HYPER-KIT sensitizes any 35mm film in hours. Best for 2415. Achieves highest possible film speeds **$325**



MODEL 600 HYPER-KIT (See photo) Like the Model 300, but also sensitizes 120/220 larger format film and small glass plates **$395**

MODEL 1200 HYPER-KIT is for 4X5" plates and film up to 5X7". Has 2 gas cylinders and includes temperature controller ... **$595**

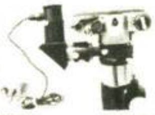
Temperature controller for any HYPER-KIT **$65**

Electric Vacuum Pump, Model R-10 **$325**

GUIDE OFF-AXIS FOR LOVELY ASTROPHOTOS

All **LUMICON EASY-GUIDER™** off-axis guiders† have both radial and 360° rotational adjustments for 5X easier guide-star selection, use 48mm filters, 360° camera rotation, large prisms for bright guide-stars.
Specify Camera and Telescope type.
U.S. Patent 4,448,500

NEWTONIAN EASY-GUIDER™



Full aperture. Installs in seconds. Specify 2" or 1¼".

NEWTONIAN EASY-GUIDER	**$169.50**
3X Relay Diagonal (see photo)	**$89.50**
Illuminated reticle eyepiece system	**$99.50**

Guider for Hasselblad **$350,** Mamiya 645 **$199**
Pentax 6X7 **add $119;** Pentax 645 **add $139**

CASSEGRAIN EASY-GUIDER™

For C-8, Meade 2080, Cynamax-8. Includes 50mm achromatic lens for f/5.8 operation—3X shorter exposures! **Superb rich field viewing, too!**

CASSEGRAIN EASY-GUIDER **$225.00**
Adapter for Hasselblad **$198,** Mamiya 645 **$98**
Pentax 6X7 **add $119;** Pentax 645 **add $139**

GIANT EASY-GUIDER™

For Celestron-11, C-14, and the 10" Meade 2120. Includes 80mm clear aperture achromatic lens for edge-to-edge illumination & pin-point star images. F-ratio adjustable f/4-f/11. **Also yields unmatched Rich-Field viewing.**

GIANT EASY-GUIDER **$395.00**
48mm DEEP-SKY Filter ordered with any EASY-GUIDER (SAVE $20) ..... **add $99.95**
Adapter for Hasselblad **$229,** Mamiya 645**$129**
Pentax 6X7 **add $129;** Pentax 645 **add $149**

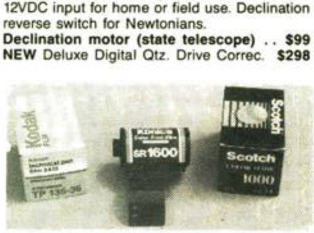
WHAT DO YOU NEED?

1. Illuminated reticle eyepiece **$99.50**
Lumicon 12mm eyepiece system has adjustable LED illumination, dual crosslines, battery pack.

2. Cable release for long exposures .. **$9.95**

3. **LUMICON Quartz Drive Corrector** . **$219**
Dual-axis drive corrector is essential for astrophotography and/or field use of your telescope. 40Hz/80Hz variable output controls telescope drive. 60Hz Quartz reference ±12VDC Declination control output. Both 110VAC and 12VDC input for home or field use. Declination reverse switch for Newtonians.

Declination motor (state telescope) .. **$99**
NEW Deluxe Digital Qtz. Drive Correc. **$298**



HYPERSENSITIZED FILM

LUMICON Hypersensitized film is essential for good deep-sky astrophotography. Deduct 10% for 3 or more rolls (mixed o.k.).***No C.O.D.s.***

Film Type, 35mm	**Exposures**	**Price**
2415, Ultra-fine B&W, red sens.	36	**$10.95**
SR-G3200, fastest of all, color neg	24	**$13.95**
Kodak Ektar 1000 fast, fine grain	24	**$12.95**
Fuji HG400 fine grain color neg.	12	**$10.95**
3M 1000, fastest slide film	12	**$12.95**
Fujichrome RD100, fine grain slide	24	**$12.95**
D-19 B&W Developer	1 gal.	**$6.95**

The Shutan Advantage:

Same-Day Shipping *and* Courteous Service!

Authorized APD Dealer!

Buy with Confidence!

30-Day Money-Back Guarantee on All Meade Accessories!

Call for our discount prices on Starfinders, APO's, LX200's and Meade Giant Binoculars!

Super Plossl: New style	
Up to 26mm	$88
32 or 40mm	110
56mm	230
Super Wide: New style	
13.8mm	140
18mm	150
24.5mm	170
32mm	240
40mm	299
Ultra Wide: New style	
4.7mm	155
6.7mm	188
8.8mm	230
14mm	270
Series II Ortho:	
4/6/9/12.5mm	50
Barlows:	
#122 2x 1.25"	$48
#127 2-2x 1.25"	60
#134 2x .96"	40
#140 2x 1.25"	80
2045 Accessories:	
AC adapter	25
Barlow 126 2x	45
Car cord	20
Carrying case	80
Tripod & wedge	240
Misc. Accessories:	
Accy case 50	67
Cat chip-8000	99
Dec 55 f/starfinder	80
Drive corr 43	99
Diagonal 915	35
Diagonal 918A	$41
Diagonal 917	29
Diagonal 927 45°	50
Diagonal 928 45°	50
Diagonal 929 2"	99
Elec. focus 1205	109
Elec. focus 1206	109
Elec. focus 1207	109
EP holder 1.25"	30
EP adapt. AD1	21
EP adapt. AD2	21
Focuser 67 1.25"	60
Focuser 71 1.25"	45
Focuser 680 2"	100
Focuser 682 2"	100
Finder brkt-8x50	20
Finder 544-8x50	70
Finder 545-8x50	$70
Finder 637-6x30	50
Finder 957-9x60	100
Filter set of 4	50
Filter set of 8	90
Filter set of 12	130
Filter ND96 1.25"	16
Illum 12mm	75
Illum 12mm-wless	95
Illum 9mm	110
Illum 9mm-wless	130
Lenshood 8"	109
Lenshood 10"	124
Nebula 908B	80
Nebula 908N	90
Nebula 910B	120
Nebula 910N	130
Nebula 911B	$100
Nebula 911N	120
Off-axis guider	80
Piggy brkt 8"	32
Piggy brkt 10"	32
Skylight/seal	48
Star charts	15
Tele extender	30
Tele ext-variable	40
T-adapt: SCT	27
T-adapt: vari-proj	40
T-adapt: .96"	28
T-adapt: 1.25"	30
T-rings	call
Vari pol 905	47
Weight set 8"	79
Weight set 10"	84

Just $3.50 ships most accessory orders via UPS • Partial listing only, call for items not listed.

Celestron:

Telescopes:	
C5 and C5+	*call*
Ultima-8 PEC	*call*
CG-11	*call*
Classic-8	*call*
Powerstar-8 PEC	*call*
Accessories:	
Coma corrector	$194
Dew shield-8"	29
Elec. focus PEC	124
Elec. dec PEC	114
MFFT-55	$139
Piigy brkt. 8"	31
Reducer f:6.3	155
Stereo viewer	479
Tele ext. *Deluxe*	45
Tripod slo-mo	48
Ultima 2x 1.25"	68
Weight assy-8"	65
Lanthanum Eyepieces:	
2.5 or 4mm	99
5, 6, or 9mm	89
10 or 15mm	89
20 or 25mm	99
30mm	139

Solar Filters

1000 Oaks

Type-2 Glass!

4" aperture	$ 74
8" aperture	119
10" aperture	134
11" aperture	144

Call for other sizes

JMI

LX200 Accessories!	
Keypad holder	32
Lev. wheeley bar	139
Elec. focuser	92
Misc:	
Elec. dec. motor for Meade SCT's	85
NGC MicroMax	*call*
NGC MiniMax	*call*
NGC-Max	*call*

Konica

ASA 3200

Color Print Film!

Five-24 exp. rolls for just $34

Just $3.50 ships most accessory orders via UPS • Partial listing only, call for items not listed.

TeleVue:

- Genesis
- Pronto
- Renaissance
- Mounts/tripods

*Call for **SHUTAN'S** Discount Prices!*

Naglers:	
4.8mm	$149
7mm	184
9mm	219
12mm Type2	259
16mm Type2	289
20mm Type2	359
Plossl:	
Up to 26mm	79
32 or 40mm	99
55mm	219
Paracorr 1.25"	139
Paracorr 2"	214
Wide Field:	
15mm	$134
19mm	139
24mm	164
32mm	234
40mm	299
Panoptic:	
22mm	259
35mm	339
Bar. interface	94
Barlows-1.25":	
2.5x or 1.8x	79
Big Barlow 2"	154

Just $3.50 ships any eyepiece order via UPS!

Family Owned & Operated for Over 75 Years!

SHUTAN camera & video

Call for 72-PAGE '93 Buying Guide! Check or charge card— always the same low price at Shutan! Don't be fooled by stores with tons of fine print in their ad. All products include full factory packaging. We ship most accessory orders for just $3.50 via UPS. Please call for telescope shipping/handling charges. All prices subject to change.

Visa, Mastercard, American Express, Discover, Check, C.O.D.

SHUTAN camera & video

312 W. Randolph • Chicago • 60606
M-F 8:30-5:30 • Saturday 9-5

Call Toll-Free!
800-621-2248
Illinois 312-332-2000

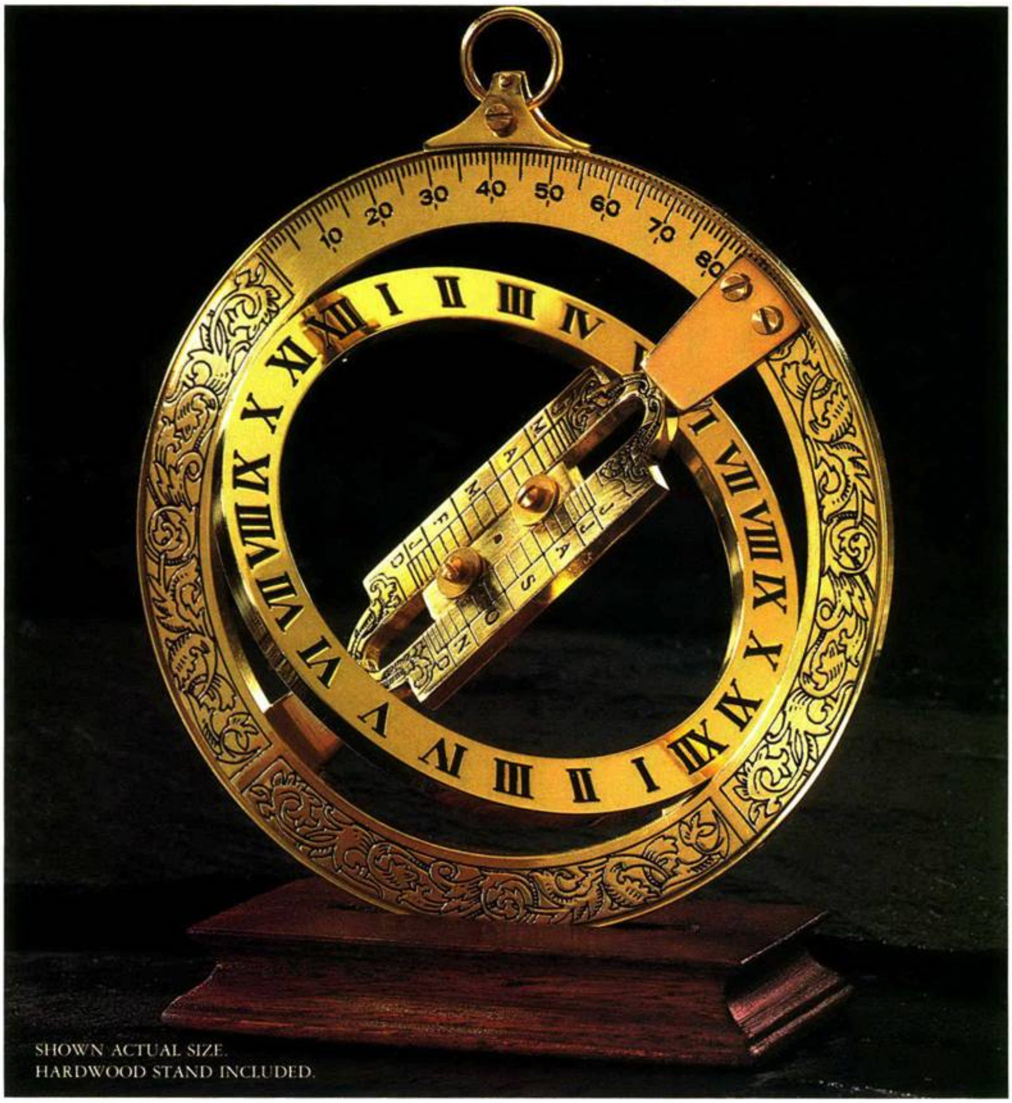
neutron stars, should release detectable amounts of gravitational waves. In the past many attempts have been made to observe the ripples in space time, but so far all have produced inconclusive results at best. If gravity waves exist, researchers feel LIGO has the greatest chance of finding them.

The press conference then took a different direction. Asked about the challenges of his disability, Hawking answered, "In fact I have found very little obstacle to my career in theoretical physics from my condition. I get embarrassed when people say I have great courage. I have only done what I intended to do anyway, before I had ALS. I think the people with real courage are those worse affected but who don't get public attention or sympathy. Yet they don't complain." Later he added, "For the physically disabled, modern technology can make up for our limitations. There is no need to discriminate on grounds of disability any more than there is on grounds of race, sex, or religion."

> **"I think the people with real courage are those worse affected but who don't get public attention or sympathy."**

One reporter then ended our two-hour audience with Hawking by asking the inevitable question reporters love to ask — "What relevance do discoveries out there in space have to the average person?" After a few minutes composing an answer on his computer, Hawking said, "They won't help feed anyone or get their wash whiter. But men and women do not live by bread alone. We all need to understand where we come from and these observations show us a glimpse of our origin." If there was a fundamental truth we were going to learn that day during our two hours with Stephen Hawking, that was it. But for those of us present that day who were astronomers and scientists, it was a truth we already knew. ☐

Measure time the way George Washington did… with this fine precision timepiece.


SHOWN ACTUAL SIZE.
HARDWOOD STAND INCLUDED.

Begin by setting the suspension ring to the local latitude.

Next, adjust the movable index to the current date.

Finally, turn the entire dial until sunlight coming through the pinhole in the index is focused on the hour ring.

THE NATIONAL MARITIME HISTORICAL SOCIETY PRESENTS THE UNIVERSAL RING DIAL

The Father of Our Country always treasured the precisely calibrated timepiece given to him by his close friend the Marquis de Lafayette.

It was the Universal Ring Dial, the fine instrument preferred by the wealthy and powerful for over 150 years. Now this precision timepiece is re-created in etched solid brass to inaugurate the official collection of the National Maritime Historical Society.

Pick it up. Turn the dial until sunlight coming through the pinhole focuses on the hour ring. And experience how Washington must have felt as he measured each dramatic moment in the birth of our nation.

Every numeral and letter—as well as the acanthus leaf design—is deeply etched into the imported brass. Priced at $90. Available only from The Franklin Mint.

SATISFACTION GUARANTEED

If you wish to return any Franklin Mint purchase, you may do so within 30 days of your receipt of that purchase for replacement, credit or refund.

THE UNIVERSAL RING DIAL

Please mail by March 31, 1993.

National Maritime Historical Society
c/o The Franklin Mint · Franklin Center, PA 19091-0001

Please send me The Universal Ring Dial in precision-crafted solid brass. I understand that I need SEND NO PAYMENT NOW. Please bill me in 3 monthly installments of $30.* each, beginning prior to shipment. The hardwood base, instructions for use and historical reference will be provided at no additional charge.

*Plus my state sales tax and a one-time charge of $3. for shipping and handling.

Issued and authenticated
by the
NATIONAL MARITIME
HISTORICAL SOCIETY
of the United States.

SIGNATURE ____________________
ALL ORDERS ARE SUBJECT TO ACCEPTANCE.

MR/MRS/MISS ____________________
PLEASE PRINT CLEARLY.

ADDRESS ____________________ APT. # ________

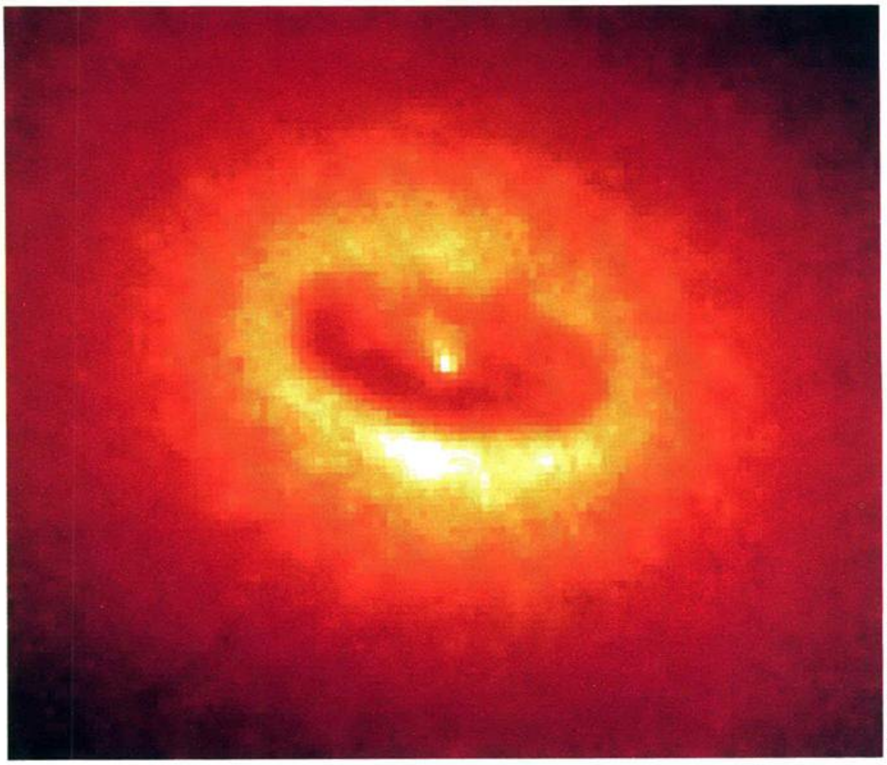
CITY/STATE ____________________ ZIP ________

TELEPHONE NO. (______) ____________________

© 1993 FM

85737-6UIE-211

HUBBLE VIEWS POSSIBLE BLACK HOLE



Walter Jaffe, Holland Ford, and NASA

A BLACK HOLE apparently powers NGC 4261, in the Virgo Cluster some 45 million light-years away. This view of the galaxy's core shows a dusty disk some 300 light-years across, which feeds matter into an accretion disk (hidden from view inside the bright center). There the matter is compressed and heated to tens of millions of degrees by the suspected black hole's gravity.

New observations made with the Hubble Space Telescope show that the elliptical galaxy NGC 4261 likely contains a supermassive black hole in its core. NGC 4261 belongs to a class of objects known as active galaxies that can generate more energy than a host of normal galaxies from a volume no bigger than our solar system. Astronomers have long suspected that supermassive black holes in the nuclei of these galaxies can explain this incredible energy output, and the new HST observations make an even stronger case for that view.

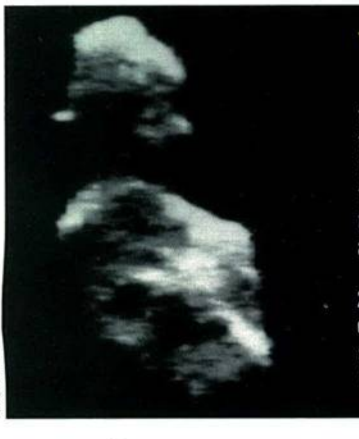
A team of astronomers led by Walter Jaffe of Leiden Observatory in the Netherlands and Holland Ford of Johns Hopkins University used HST's Wide Field/Planetary Camera (WF/PC) to image the core of NGC 4261, at magnitude 10.3 one of the dozen brightest members of the nearby Virgo Cluster of galaxies and also a strong source of radio radiation. What they found was a dark disk of material surrounding an intensely bright source at the galaxy's center. The disk is tipped about 60° to our line of sight, providing astronomers with a remarkably clear view into the galaxy's central region.

"This is our best view to date of the immediate surroundings of the nucleus of an active galaxy," says Jaffe. The dark disk is a cold outer region of dust and gas that spans about 300 light-years and extends to within a few hundred million miles of the presumed black hole. Hidden inside the bright source at the center of this cool region lies an intensely hot accretion disk, where the black hole's tremendous gravity slowly but inexorably draws in matter from the outer disk, compressing and heating it to tens of millions of degrees. Some of the hot gas squirts out from the black hole's vicinity like twin streams of water from a lawn sprinkler.

Even before the HST observations, astronomers viewed NGC 4261 as an exceptional galaxy. "Though the galaxy is unremarkable in visible light," says Jaffe, "observations with radio telescopes showed a pair of opposed jets emanating from the nucleus and spanning a distance of 88,000 light-years." The HST results add detail to this picture. According to Ford, "The spin axis of the newly discovered disk orients the radio jets. The cooler, outer regions of the washer-shaped disk confine the ionizing radiation from the hot interior into a pair of cones whose axes are parallel to the radio jets."

The presence of the disk does present a mystery, however: elliptical galaxies don't typically contain dust and cool gas. The researchers suggest that the dust could be the remains of a spiral galaxy that NGC 4261 swallowed in the recent past. The influx of new material also could have provided fuel to the black hole, causing the galaxy's high level of activity.

Following the space shuttle servicing mission scheduled for late 1993 (see "How We'll Fix Hubble," February 1993), the researchers hope to use HST's spectrographs to study the motion of the gas within a few dozen light-years of the suspected black hole. This might allow them to confirm the black hole's existence by accurately measuring the mass of the galaxy's nucleus.



NASA/JPL

TOUTATIS IS A BINARY ASTEROID

The first radar images released by NASA of asteroid 4179 Toutatis show it has both a binary nature and a rough surface. "It's a wonderful, incredibly strange object," marvels Steven Ostro, the JPL astronomer who headed the team making the images. Toutatis flew past Earth December 8 at a distance of 3.6 million kilometers.

Toutatis is two roughly spherical pieces of rock, 2.5 and 4 km in diameter, which appear to lie in contact. One 700-meter crater is visible. "Toutatis' surface is rough at a scale of a few inches," says Ostro. "But it also has considerable dust on it."

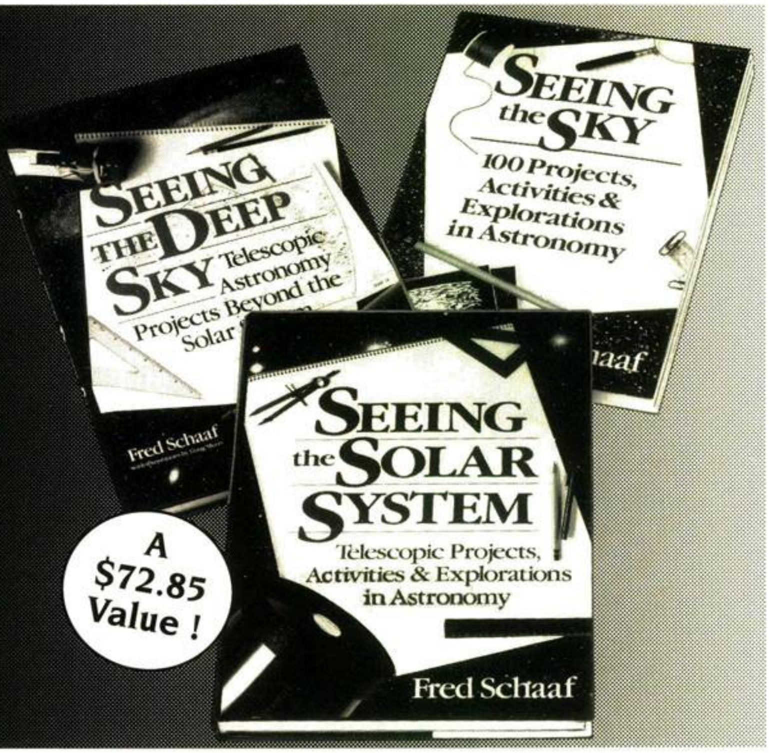
SEE THE UNIVERSE for just $2.95

Noted Columnist Fred Schaaf Brings You Over 180 of His Favorite Projects, Activities, and Explorations

It's your no-risk introduction to the

Astronomy Book Club

You simply agree to buy three more books — at significant savings — within the next 12 months.


SEEING THE DEEP SKY Telescopic Astronomy Projects Beyond the Solar System
Fred Schaaf
SEEING the SKY 100 Projects, Activities & Explorations in Astronomy
SEEING the SOLAR SYSTEM Telescopic Projects, Activities & Explorations in Astronomy
Fred Schaaf
A $72.85 Value !

Bring the universe into your backyard with this extraordinary three-volume set. You get over 180 small telescope and naked-eye projects. Best of all, you can own this $72.85 set for only $2.95. So return the postage-paid card today.

The STARRY ROOM
Naked Eye Astronomy in the Intimate Universe
FRED SCHAAF
Foreword by Chet Raymo

Softcover

Yours FREE

for responding within three weeks
—a $12.95 value —

"Fred Schaaf's knowledge and intensity will inspire even the veteran sky-watcher . . .this is a book that will help redefine amateur astronomy."
— Chet Raymo, author of 365 *Starry Nights*

Membership Benefits

In addition to getting Fred Schaaf's SEEING THE UNIVERSE SET for only $2.95 and THE STARRY ROOM absolutely FREE when you join, you'll also receive discounts on books you choose to purchase. Discounts generally range from 15% to 30% off the publishers' prices, and occasionally even more. • Also, you will immediately become eligible to participate in our Bonus Book Plan, with savings of 50% off the publishers' prices. • Moreover, our books are always identical to the publisher's editions. You'll never receive an "economy edition" with inferior paper and bindings from us. • At 3-4 week intervals (15 times per year), you will receive the Astronomy Book Club News, describing the coming Main Selection and Alternate Selections, together with a dated reply card. • In addition, up to three times a year, you may receive offers of Special Selections which will be made available to a group of select members. • If you want the Main Selection, do nothing, and it will be sent to you automatically. • If you prefer another selection, or no book at all, simply indicate your choice on the card and return it by the date specified. • You will have at least 10 days to decide. If, because of late mail delivery of the News, you should receive a book you do not want, we guarantee return postage.

THE ASTRONOMY BOOK CLUB
Whether you're a professional or amateur enthusiast, the ASTRONOMY BOOK CLUB offers you the finest astronomy materials available. You'll enjoy atlases and how-to manuals, as well as textbooks and popular guides covering the latest discoveries, and the opportunity to purchase them conveniently and inexpensively.

If reply card is missing, please write to the ASTRONOMY BOOK CLUB, Dept. L-DF7/00233, 3000 Cindel Drive, Delran, NJ 08370-0001 for membership information and an application.
Astronomy 3/93 © Newbridge Communications, Inc.

Seeing The Sky

Over 100 naked-eye activities bring the universe into your backyard. Find out how to:

- See Venus as a morning star and an evening star. . . in the same day
- Split the Big Dipper's Mizar-Alcor and other double stars
- Estimate the length of a bright comet's tail and observe little-known meteor showers
- Identify dozens of lunar features with the naked eye

Seeing The Deep Sky

35 telescopic explorations take you to the outer limits of the universe. You'll discover how to:

- Estimate the temperature of a star by its color
- Observe the much-studied filaments of the Crab and Veil Nebulae
- Calculate a variable star's period and amplitude
- Locate galaxies of all types

Seeing The Solar System

Over 50 telescope projects unlock the secrets of the solar system. You'll see how to:

- Spot lunar transient phenomena and identify features of craters
- Compare the color of Neptune's moons with those of Uranus
- Determine the Schroeter effect on Venus
- Learn how the angle of tilt of Saturn's rings affects their visibility

Return the postage-paid reply card today to get the 3-volume set SEEING THE UNIVERSE —a $72.85 value– for only $2.95!

SPACE TELESCOPE PROBES GALAXY EVOLUTION . . .

Clusters of galaxies located far away in space and far back in time apparently contain several times as many spiral galaxies as do nearby, older clusters. These new findings come from detailed images of two distant galaxy clusters made with the Hubble Space Telescope and should help astronomers better understand how galaxies evolve.

One of the principal goals for HST is to trace galaxy evolution by means of direct observations. Such observations are extremely difficult to carry out with ground-based telescopes because Earth's turbulent atmosphere smears the tiny images of distant galaxies into faint blurs. Astronomers at first thought the optical problems with HST's primary mirror would prevent them from achieving this goal until after the shuttle servicing mission, but the latest images show that is not necessarily so.

Alan Dressler of the Observatories of the Carnegie Institution, Augustus Oemler of Yale University, James Gunn of Princeton University, and Harvey Butcher of the Netherlands Foundation for Research in Astronomy photographed the two clusters with HST's Wide Field/Planetary Camera (WF/PC). Both have a redshift of $z = 0.4$, placing them approximately 4 billion light-years from Earth. The images show that the universe of 4 billion years ago contained the same range of galaxy types as we see today: elliptical, spiral, lenticular (or S0), irregular, and distorted galaxies.

Alan Dressler, Augustus Oemler, James Gunn, Harvey Butcher, and NASA

LOTS OF GALAXIES PEPPER the remote cluster designated CL 0939+4713, which lies about 4 billion light-years away. This HST image reveals several times more spirals than typically seen in nearby clusters, implying that these galaxies evolve, most likely through mergers, disruption, and fading.

Alan Dressler, Augustus Oemler, James Gunn, Harvey Butcher, and NASA

THE FARTHEST GALAXY CLUSTER KNOWN may be this grouping of about 30 very faint objects found serendipitously in an HST image of the closer cluster CL 0939+4713. The larger objects are foreground galaxies in the nearer cluster.

The images also reveal colliding galaxies, some apparently tearing material from each other while others are merging into single systems.

"The pictures show us that clusters billions of years ago contained not only the elliptical and S0 galaxies like those dominating their descendant clusters today, but also several times as many spiral galaxies," says Dressler. "The new Hubble data are the first unambiguous sign of the influence of environment on the form of a galaxy."

The team thinks the decline in the population of spiral galaxies in modern clusters can be explained by three mechanisms: merger, disruption, and fading. The HST photos show many examples of galaxy interactions and mergers. Perhaps many of the ancient spirals merged to form giant elliptical galaxies, as proposed by astronomers Alar Toomre and François Schweizer, or were simply torn apart and dispersed by what Dressler calls the "Cuisinart environment." This may not be the whole story, however. Dressler and Gunn previously found bursts of star formation to be much more common in spiral galaxies of the distant past, and those galaxies may have faded enough that they go unnoticed in today's nearby clusters.

. . . AND DISCOVERS MOST DISTANT GALAXY CLUSTER

These same Hubble observations discovered a galaxy cluster that may turn out to be the most distant cluster ever seen, located some 10 billion light-years away. Lying in a corner of one of the HST images is a grouping of about 30 very faint objects. "The smaller, more compact appearance of the objects suggests that they are in the background and thus much farther away than the foreground galaxies," says Dressler. At the least, the distant cluster seems to be among the most distant clusters known.

But even more exciting is the presence of a quasar in the same field of view. "Though the superposition of the cluster objects and the quasar could be a coincidence, both are so unusual that there is good reason to believe that all are members of the same cluster and at the same distance," according to Dressler. The quasar has a redshift of 2.055, placing it about 10 billion light-years from Earth, which would place this galaxy cluster much farther away than any other. Astronomers should be able to measure the redshifts of these objects from the ground, which will confirm whether they are at the same distance as the quasar.

Unfortunately, the Hubble image doesn't show enough detail to determine what kind of galaxies they are. But once HST's full optical capabilities are restored in late 1993, the telescope will be able to resolve the morphology of these galaxies and those in other distant clusters. That will give astronomers the ability to study galaxy evolution over an even wider range of environments and at even earlier epochs.

WHAT STARS CREATE BLACK HOLES?

Recent improvements in computer models of stellar interiors make it possible to explore the range of stellar masses that create black holes at the end of their life cycle. André Maeder of the Geneva Observatory in Switzerland has constructed one set of models for stars with masses from the Sun's to 120 times the Sun's. He wrote in the October (I) 1992 *Astronomy and Astrophysics* that stellar masses above 20 to 25 times the Sun's produce black holes, excluding cases where all of the pre-supernova star's outer layers are ejected.

Stars below this mass limit produce neutron stars of 1.48 to 1.67 solar masses, although some models suggest the neutron star may contain as much as twice the Sun's mass. So stars with initial masses of about 8 to 20 solar masses form neutron stars while more massive stars form black holes. However, Maeder also found that black holes may not form for stars above 20 solar masses but below 30 to 40 solar masses if the star contains significant amounts of elements other than hydrogen and helium. These stars lose too much mass to become black holes and instead become neutron stars. This result implies that black holes formed more easily when galaxies were young and the stars' nuclear fires had not yet produced heavy elements.

GEMINGA ON THE MOVE

Following close on the heels of the confirmation that the mysterious gamma-ray object known as Geminga is a pulsar and neutron star (see AstroNews, January 1993), astronomers have deduced that Geminga is also the nearest known neutron star. The new measurement places Geminga about 300 light-years from Earth, just a small fraction of the Milky Way Galaxy's diameter of more than 100,000 light-years.

Though Geminga ranks as the second-brightest object in the gamma-ray sky, it is exceedingly faint in visible light, faintly glowing at magnitude 25.5. Nevertheless, Italian astronomers Giovanni Bignami, Patrizia Caraveo, and Sandro Mereghetti of the Istituto per Ricerce in Fisici Cosmica e Technologie Relative in Milan used optical photographs to estimate Geminga's distance.

The researchers studied three photos of Geminga taken over an eight-year period — one taken with the Canada-France-Hawaii telescope in January 1984, the second taken with the 3.6-meter telescope at the European Southern Observatory in La Silla, Chile, in January 1987, and the most recent with the 3.5-meter New Technology Telescope at the European Southern Observatory in November 1992.

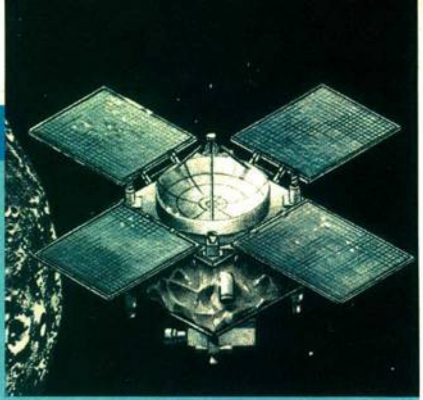
They found that over that eight-year span, Geminga moved 1.5 arcseconds relative to the more distant background stars of Gemini. This is far faster than most stars move, implying that Geminga is relatively close. (When all other things are equal, the closer an object is to us, the faster it appears to drift across the sky.) If Geminga moves through space at the average rate of other

Space News

ASTEROID MISSION ON THE DRAWING BOARD

Engineers at Johns Hopkins University's Applied Physics Laboratory (APL) have begun to design a new low-cost probe to explore an asteroid. Called NEAR (Near-Earth Asteroid Rendezvous), the mission is part of NASA's Discovery program for exploring the solar system with bargain-fare spacecraft. "APL's design for NEAR is very appealing to us. I think this is a mission we can make happen," said Lennard Fisk, NASA's chief scientist. NASA recently awarded the laboratory $450,000 to begin the design work for the new mission.

The NEAR spacecraft could be launched as early as January 1998 and begin orbiting the asteroid 4660 Nereus two years later. Nereus is one of the near-Earth asteroids that orbit close to the Sun and whose orbits cross Earth's path. Skimming the asteroid's surface at altitudes as low as one mile, the probe would orbit Nereus for a year, providing the first long-term closeup study of an asteroid.



Johns Hopkins University Applied Physics Laboratory

A NEW SPACE PROBE to explore a near-Earth asteroid is one of NASA's top priorities for the next decade of planetary exploration.

Construction of NEAR could begin in 1996. The quick two-year construction period and the probe's simple design are crucial to the mission's tight $150 million budget. For example, solar panels will be the only parts of the craft that require deployment after launch, minimizing potential trouble spots in essential components such as antennas. Yet despite its simplicity, NEAR will carry an impressive complement of experiments: a gamma-ray spectrometer, an imaging spectrograph, a laser altimeter, a magnetometer, and a CCD camera capable of photographing details on Nereus' surface as small as two inches across.

HUBBLE MISSION CAPS 1993 SHUTTLE SCHEDULE

NASA's 1993 schedule for the space shuttle calls for eight flights, the last of which is the mission of most interest to astronomers, the repair of the Hubble Space Telescope. During this eight-day mission, Endeavour astronauts will install the new Wide Field/Planetary Camera (WF/PC II) and the corrective optics package called COSTAR and replace the solar panels. The repair flight is now set for launch on December 7, 1993. The year's other shuttle flights include the following:

January — Endeavour carries another in the series of Tracking and Data Relay Satellites into orbit.

February — German astronauts on board Columbia perform a nine-day microgravity mission with the German Spacelab.

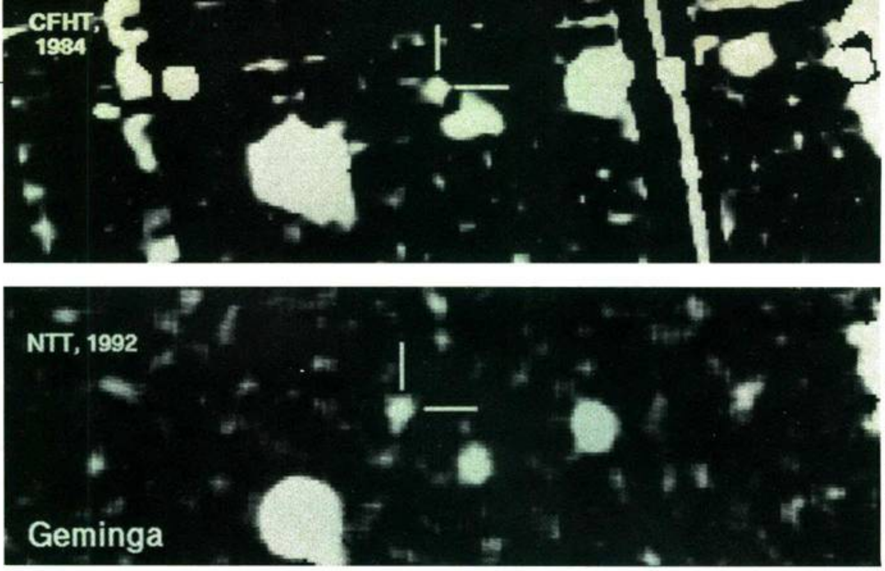
March — Discovery conducts Earth-observation and astronomy experiments with the second flight of the ATLAS atmospheric science package and with a free-flying, X-ray astronomy satellite called Spartan.

April/May — Endeavour orbits for seven days with Spacehab-1, a privately built pressurized module for conducting microgravity experiments for various commercial clients. Astronauts also retrieve the European-built EURECA platform after 10 months in orbit.

July — Discovery launches the Advanced Communications Technology Satellite. Astronauts also release, then retrieve, a free-flying satellite called Astro-SPAS which will contain an ultraviolet telescope, the Orbiting and Retrievable Far and Extreme Ultraviolet Spectrometer, or ORFEUS. The free-flyer platform also carries an IMAX camera for capturing giant-screen movie footage of the shuttle in the distance performing orbital maneuvers.

August/September — Columbia astronauts spend 13 days conducting the second Space Life Sciences mission.

November — Discovery carries the second commercial Spacehab module into orbit for seven days, along with the first Russian cosmonaut to fly on a U.S. spacecraft.



European Southern Observatory

GEMINGA MOVED 1.5 arcseconds relative to more-distant stars in the eight-year period from 1984 to 1992, establishing it as the closest known neutron star to Earth at a distance of about 300 light-years.

known pulsars, about 100 km per second, then it lies some 300 light-years away. And at that distance, the gamma-ray radiation emitted by Geminga is about that expected from a normal neutron star.

URANUS AND THE SEARCH FOR PLANET X

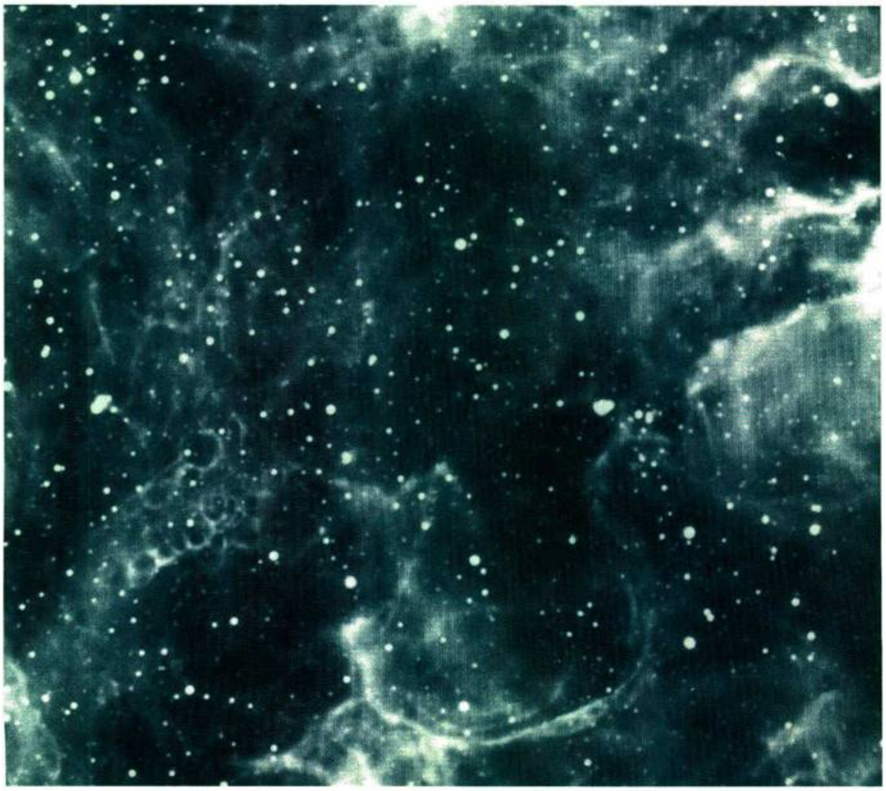
The observed positions of Uranus disagree with the positions predicted by the most sophisticated dynamical models of its motion. Some astronomers have used these discrepancies, or residuals, to suggest the presence of a tenth planet in our solar system. The gravity of this Planet X, they argue, disturbs the motion of Uranus, producing the observed residuals. However, astronomers have been unsuccessful in their search for this planet, and many astronomers doubt its existence.

A. Brunini of the Universidad Nacional de La Plata in Argentina proposed a simpler explanation in the October (I) 1992 *Astronomy and Astrophysics.* Brunini ran a computer simulation of Uranus' motion that included a collision about 100 years ago of an icy body 500 to 1,000 km in diameter with Uranus. The simulation produced residuals incredibly similar to those observed. Encounters between icy bodies and the planets are rare, but they do occur. For example, the retrograde orbit of Triton around Neptune and the pairing of Pluto and Charon most probably result from such encounters. Astronomers now need to study the other possible effects of the collision and construct a more complete dynamical model to test Brunini's hypothesis.

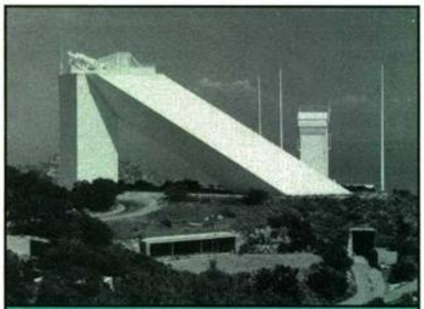
A HONEYCOMB IN THE LARGE MAGELLANIC CLOUD

Astronomers have discovered a strange nebula in the Large Magellanic Cloud (LMC) that bears a striking resemblance to a honeycomb. Though bubbles of interstellar gas are a common sight in the LMC, at 169,000 light-years away the closest galaxy to our own Milky Way Galaxy, no one had

THE HONEYCOMB NEBULA was discovered accidentally on this image of part of the Large Magellanic Cloud. The nebula lies at the lower left, while Supernova 1987A is the bright, slightly elongated object right of center.

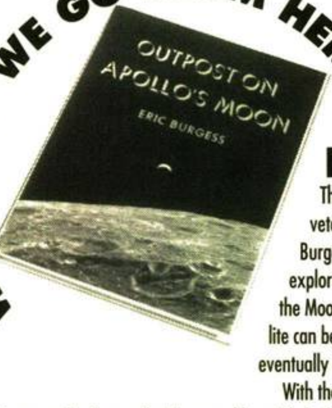


European Southern Observatory and Lifan Wang



National Optical Astronomy Observatories

KITT PEAK'S McMATH SOLAR TELESCOPE is now called the McMath-Pierce Solar Telescope, in honor of Keith Pierce. Pierce helped Robert McMath design the telescope and oversee its construction starting in 1958. He remained as a solar astronomer with the then-fledgling Kitt Peak National Observatory, designing instruments for the telescope and studying the Sun's spectrum. Thirty years after its dedication, the 1.5-meter-diameter telescope remains heavily used for infrared solar observations and nighttime observations of stars, planets, comets, and the Moon.



WHERE DO WE GO FROM HERE?

ERIC BURGESS

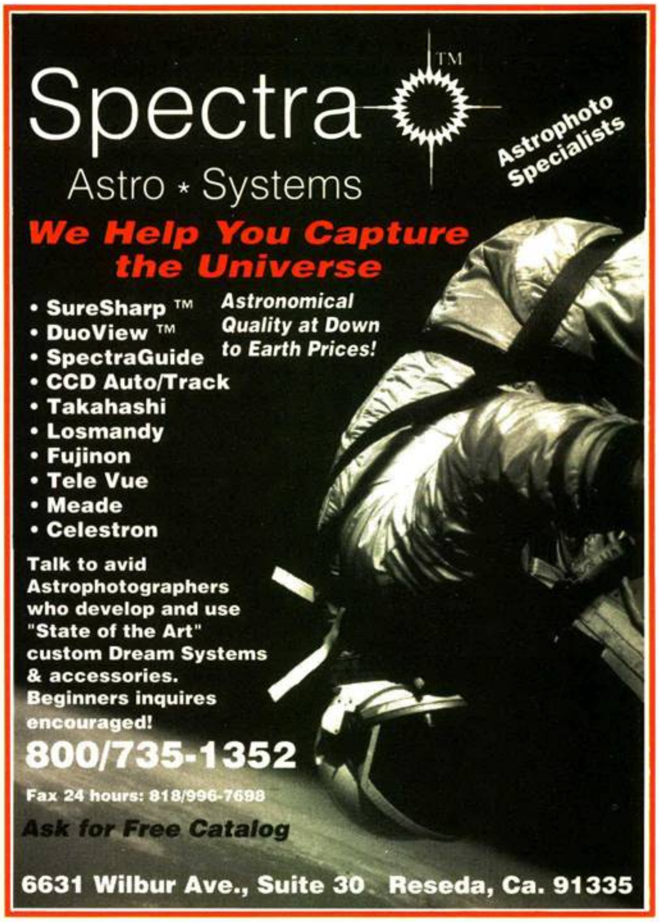
This latest work by veteran space writer Eric Burgess examines how past exploration and analysis of the Moon proves that this satellite can be further developed and eventually colonized.

With the application of already-existing space hardware, the Moon could provide both a location for research centers, tourist attractions, economic resource development, and rehabilitation centers, and a future home for the ever-growing population of the Earth.

"With text, photos, and diagrams [Burgess] does a good job of making clear to any interested layman some rather difficult-to-understand matters."
—ASTRONOMY

ONE HUNDRED YEARS & BOUND FOR MORE
COLUMBIA UNIVERSITY PRESS
1893 – 1993

288 pp / 111 photos, 39 Illus / 8.5 x 11" / $34.95
Dept. T76 • 136 South Broadway, Irvington, NY 10533
Credit cards accepted.
Tel: (800) 944-UNIV • Fax: (800) 944-1844



Spectra™
Astro ⋆ Systems

Astrophoto Specialists

We Help You Capture the Universe

- **SureSharp ™**
- **DuoView ™**
- **SpectraGuide**
- **CCD Auto/Track**
- **Takahashi**
- **Losmandy**
- **Fujinon**
- **Tele Vue**
- **Meade**
- **Celestron**

Astronomical Quality at Down to Earth Prices!

Talk to avid Astrophotographers who develop and use "State of the Art" custom Dream Systems & accessories. Beginners inquires encouraged!

800/735-1352

Fax 24 hours: 818/996-7698

Ask for Free Catalog

6631 Wilbur Ave., Suite 30 Reseda, Ca. 91335

WHOLESALE OPTICS OF PENNSYLVANIA *For All Your Astronomical Needs*

TELRAD w/Base $39.00
Batteries Included!

Extra Reticles	**$2.95**
Extra Bases	**$7.95**
Hinged Deluxe Dew Caps	**$10.00**
Plusar Unit	**$19.95**

TeleVue Eyepieces, Genesis, Pronto, Gibraltar Mounts at Midwinter Sale Prices

"PRONTO" 70MM, 450fl w/E.D. objective. Avail. w/2" Star diagonal or porro prism, 21MM Plossl. Fits all standard camera tripods.

SPECIAL PROMOTION ON GENESIS AND GIBRALTAR MOUNT
Contact us for exciting details!

EDMUND SCIENTIFIC Astro Scan 2001
4¼" Port. Reflector Scope $288.00
(See Edmund Eyepieces & Acces. listing in this ad)
Ideal first scope or portable second. Goes everywhere. IN STOCK for immediate delivery.

JIM'S MOBILE

Moto-Focus LX3/5/6/200	$78.00
Moto-Decs LX3/5/6/200	$75.00

Moto-Focus and Moto-Decs for all scopes avail. Contact us for special sale prices on NGC Mini Max, NGC Max, Micro Max and SGT Max. **New — NGF-2** Deluxe Focuser (used on NGT's) with or without Motor focus Now Available. NGT-18 Scopes available.

B&L 8x50 FINDER St. thru $48.00
MOUNTING BKTS. Spec. SCT or Newt. $30.00
6x30 Rt. Angle Finder $48.95
6x30 Bracket $29.00

NEW SOLAR PROMINENCE FILTERS FOR 1993
See actual solar prominences with your refractor or Cassegrain with new Thousand Oaks Optics Solar Prominences Packages. Contact us for introductory specials.

SOLVE FOCUS PROBLEMS FOREVER
with Spectra's Sure-Sharp Optical Grid Focusing method for perfectly focused astrophotos.
Sure-Sharp $135.00 Rt. Angle viewer **$49.00** Point Source **$59.00** Duo-View **$79.00**

QUARTZ DRIVE CORRECTORS BY VOGEL — ALL DIGITRAK II

SINGLE AXIS		DUAL AXIS	
VE-200 Runs off DC	$132.95	VE-200 D	$174.95
VE-300 Runs off DC/AC	$159.95	VE-300 D	$212.95
VE-400 Runs off DC/AC or Int. Battery	$198.95	VE-400 D	$262.95
Interface Cable for SBIG-4	$17.95	VE-100 Inverter (converts your motor to DC)	$71.95

PORTA-PAC $65.00
12 AMP HR.
Heavy Duty
PORTA PAC $86.95

Tectron Collimators improve Newtonian images w/the following

Sight Tube	$29.00	Auto-collimator	$31.00
Cheshire Eyep.	$38.00	Above 3 w/Bklt	$95.00

New "Revised" Booklet on Collimation . . . $6.00

For that Fast New Scope you're building or for upgrading your current scope —

New - The Modern Dobsonian Booklet	$11.00
Ultra Low Rack & Pinion Focusers 2" w/1¼" Adptr.	$125.00
Photographic Focuser	$159.00

BOOKS & STAR CHARTS

MAG 5 Star Atlas	$6.95
MAG 6 Star Atlas	$16.95
1000 Plus	$39.95
Sky Atlas 2000 Field	$16.95
Sky Atlas 2000 Desk	$16.95
Sky Atlas 2000 Color	$43.95
Laminated Deluxe 2000 Color	$84.95
Laminated 2000 Field or Desk	$58.95
Burnham's Handbook — All 3 Volumes	$35.85
Norton's Sky Atlas	$34.95
Uranometria Vol. I or II	$39.95
Astrophotography for the Amateur Revised, Soft Back	$19.00
How to Choose Binoculars by A. Hale	$13.00
Astrophotography by Gordon	$19.50
Astrophotography II by Martinez	$18.00
Backyard Astronomers Guide	$38.95
Touring the Universe through Binoculars by Harrington	$29.95

EYEPIECE SPECIALS!!
New Generation LV Series Eyepieces Have Arrived! Contact us for details.
BUY DIRECT AND SAVE
Coated and threaded for filters:

11/4" Kellners 6,9,12,18,25MM	$29.00
11/4" Ortho's 4,5,6,7,9,12.5,18,25MM	$39.00
11/4" 16.0MM Erfle	$50.00
11/4" 20.0MM Erfle	$55.00
11/4" 25.0MM Erfle	$57.00
11/4" 32.0MM Erfle	$59.00
11/4" 2x Barlow	$39.00
11/4" 8.4-21 ZOOM	$85.00
12.5 Wireless Illum. Reticle Plossl	$95.00
9MM Wireless Illum. Reticle Plossl	$116.00
CELESTRON 35MM ULTIMA 1¼"	**$74.95**

BINOCULAR SALE!
We carry Zeiss • Fujinon • Adlerblick • Swarovski • Minolta • Swift • Celestron • Aus Jena • Meade • Kowa • B&L • Steiner • Pentax

Fujinon 7 × 50 FMT-SX	**$365.00**
10 × 70 FMT-SX	**$439.00**

THOUSAND OAKS SOLAR FILTERS THE BEST!
Enjoy continued high solar activity.

Type I 8"	$90.00	Type II 8"	$120.00
Type I 10"	$100.00	Type II 10"	$130.00

ALL sizes available for all scopes. Type III and new thread ins avail.

EDMUND SCIENTIFIC EYEPIECES & ACCESSORIES

11/4" RKE 8, 12, 15, 21 or 28MM	$39.95
RKE 2.5X Barlow	$64.95
11/4" Orthos 4, 6, 12.5, 18 or 25MM	$49.95
Ortho Zoom 8.4-21MM	$91.95
11/4" Kellners 6, 9, 12, 18 or 25MM	$33.95

Astro Flashlights

Red Led Chartmaster	$17.50
Small Setup $8.00 Large Setup	$12.00

2" 32MM Wide Field Erfle . . $119.00

ASTRO-SCAN ACCESSORIES:

Tripod Bkt.	$41.95
Tote Bag	$29.95
Variable Cam. Ad	$67.95
St. Thru Image Erector	$59.00
Sun Viewing Screen	$45.95

ALL EDMUND PRODUCTS AVAILABLE
CONTACT US FOR PRICES

ACCESSORIES CORNER

T-Rings (spec. camera make)	**$10.00**
Tele-Extenders for SCT's	**$22.00**
T-Adapters for SCT's	**$22.00**
Color & Moon Filters	**$13.00**
Set of 6 Filters 1.25"	**$59.95**
Drives for Tasco Eq. Mount	**$89.95**
Anti-Vibration Pads for Tripods	**$45.00**
Tripod Slo-mo controls	**$46.00**
New Deluxe Optics Cleaning Kit	**$19.00**
Celest. F6.3 Reducer/Corrector	**$139.00**
Celestron .96 Star Diagonal	**$19.95**
Celestron Photo Deluxe Tripod	**$95.00**
12 Volt Dew Remover Blower	**$11.95**

LUMICON Deep Sky UHC H-Beta OX III in stock

All Parks optics, mirrors & access. We also carry Kowa and Mirador Spotting Scopes. We're now dealers for D&G Optics Refractors, Opto-Data Starport, Tech 2000 Dob. Drivers & Bogen Tripods/Skyhook for Binos Now in Stock

COMPUTER SOFTWARE

STARGAZE	$79.95
EZ COSMOS - NEW 4.0 DOS & WINDOWS AVAIL	
DANCE OF THE PLANETS	$159.95

"THE SKY" • DISTANT SUNS
Astronomy Software Avail./Specify Disk Size

BEATTIE INTENSCREEN — PLUS
Ultra bright focus screens for:

Olympus OM-1,2,3,4	$58.95
Nikon F, F2, F3	$93.95
Nikon FE, FE2, FM2, FA	$58.95

MEADE • CELESTRON • TELE VUE • B&L • BRANDON • PARKS • PENTAX • UNIVERSITY OPTICS • JMI • THOUSAND OAK FILTERS • QUESTAR
TECTRON • EDMUND SCI • FUJINON • ZEISS • SWIFT • VOGEL • DAY STAR FILTERS • LUMICON • aus JENA • BOGEN • KOWA • MINOLTA and more

Wholesale Optics of Pennsylvania

Wholesale Optics of Pennsylvania
North Pocono Village Shopping Center
RR 6, Box 6329, Moscow, PA 18444
Showroom Hours, 10-5
Speak with amateur astronomers . . . Ask for Glenn-ARS: K3WEI or DON, KD3LN

Call till 9 PM: (717) 842-1500
P. List send SASE with 58¢ in stamps
3% Cr. Cg.
★ *WORLDWIDE SHIPPING* ★

FAX 717-842-1408 24 hrs.
Cat. $5.00 (within U.S.)
$8.00 to Canada
$10.00 Elsewhere
$5.00 MIN. SHIPPING — U.P.S. (IN U.S.)

ASTRONOMICAL LEAGUE

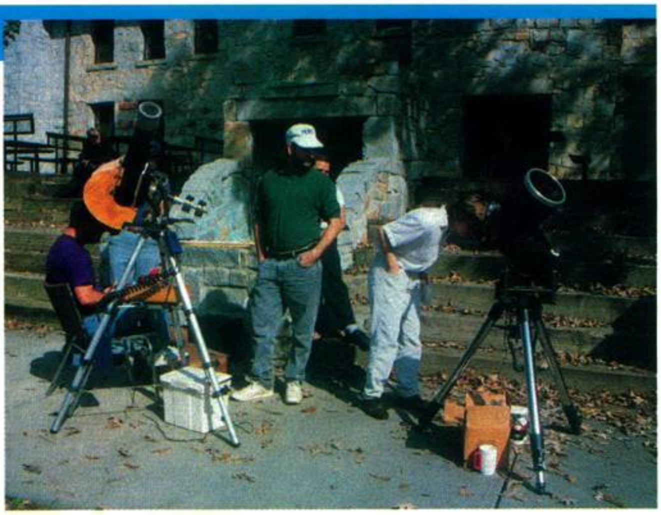
ever seen anything quite like the "Honeycomb." The newly discovered nebula consists of a cluster of at least ten roughly circular bubbles of gas, each of which measures about 10 light-years across.

Lifan Wang of the University of Manchester in England discovered the Honeycomb accidentally while studying the interstellar environment around Supernova 1987A. It turned up in an H-alpha image made with the 3.5-meter New Technology Telescope at La Silla, Chile.

Though the nature of the Honeycomb won't be known until astronomers study the region in more detail, one possibility is that the "bees" making the honeycomb pattern are a swarm of massive stars. Such stars possess strong stellar winds, which could blow the surrounding interstellar gas into the bubble shapes. (See "Bubbles in the Sky," January 1993.) To produce a cluster of bubbles so similar in size, however, the stars must have formed at the same time and with the same initial mass, and be evolving at the same rate. Their simultaneous formation could have been triggered by a single event, perhaps an ancient supernova explosion.

Amateur News

THE NIGHT THE STARS CAME OUT IN GEORGIA


Ken Poshedly

SOLAR TELESCOPES provided views of the daytime star at last autumn's Georgia Star Party near Atlanta.

The 1992 Georgia Star Party was a rousing success. With a final tally of 104 registrants, the 1992 event was the most successful in the four-year history of star parties staged by the Astronomical Society of the Atlantic.

Held October 22 to 25 at the Future Farmers of America campground outside Covington, Georgia, the event was also home to the annual convention of the Southeast Region of the Astronomical League.

Comet Swift-Tuttle was the star attraction, along with many favorite Messier and NGC objects. Another highlight included the chance for observers on Friday and Saturday nights to share their enthusiasm with small groups of youngsters from the Red Cross Youth Leadership Conference being held at the camp that weekend. Saturn, the double star Albireo, and several prominent nebulae and galaxies provided a goodly number of oohs and aahs, while questions from the youthful guests challenged the observers to explain just what it was they were peering at in those eyepieces.

The society obtained considerable publicity for the star party. Channel 2 weatherman Glenn Burns gave prominent on-air mention to the star party, complete with a large graphic indicating the name of the event, along with the date, location, and the society's telephone information line. The *Atlanta Journal-Constitution* ran a sizable newspaper story that also included a map to the site.

A well-attended feature of this year's GSP was the series of afternoon talks on Friday and Saturday. Talks by Sam Choate, Tom Lorenzin, Mark Coco, Doug Gegen, Don Barry, and Jim Rouse (chairman of the 1992 event) were real crowd pleasers. The astrophotography contest, a first in 1992, drew some great images.

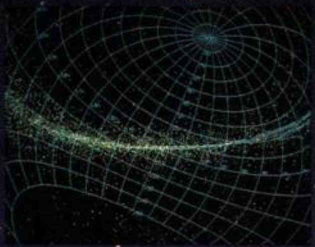
And thanks to generous donations of door prizes from companies such as Celestron, Canon, and many more, there were a lot of smiling faces exiting the speakers' hall Saturday afternoon. Winners took home Celestron 15x80 binoculars, an autographed copy of Terence Dickinson and Alan Dyer's highly acclaimed book *The Backyard Astronomer's Guide*, an autographed copy of Tom Lorenzin's *1,000+, A Guide to Deep Sky Observing*, eyepieces from Parks and Tele Vue, computer software, posters and maps, and lots more.

To learn more about the Astronomical Society of the Atlantic or to get on the mailing list for information on the 1993 Georgia Star Party, write to the Society, c/o Center for High Angular Resolution Astronomy, Georgia State University, Atlanta, GA 30303-3083. — *Ken Poshedly*

ATTENTION ALL CLUBS

ASTRONOMY magazine wants to hear from your club. We're currently updating our list of clubs and organizations for publication in our upcoming annual Astronomy Directory. In December we sent out survey forms to all astronomy groups on last year's list. If your club did not receive and return a form, please contact us ASAP so we can add you to our listing. Drop us a letter or FAX telling us your club's name, mailing address, and the name and phone number of a contact person in your group. Include information about the year your club was founded, how many members your club has, details of any telephone hotlines or computer bulletin boards your group operates, and the dates and places for major star parties, conferences, or special public events your group is planning in 1993. Write to ASTRONOMY's Annual Directory, P.O. Box 1612, Waukesha, WI 53187-1612. Or FAX us at (414) 796-1142 or phone (414) 796-8776, ext. 605. We need to hear from you by February 12.

ALTER FOREVER YOUR SENSE OF SPACE AND TIME



Flowing time and motion brings life to the sky and solar system.

Through the power of gravitational simulation, break your bounds to the present. Seasonal motions, retrograde epicycles, comet and planet apparitions, eclipses, occultations, conjunctions... ephemeral events, all a pleasure to watch in the natural flow of time.

Go *beyond* the calculable to find orbital precession, resonance, and chaos. See where asteroids and comets are at any time; study the satellite and ring systems. Learn how Jupiter keeps things stirred up. Find lost comets, and witness future orbit-changing encounters. And of course enjoy a beautiful, starry sky, from space or Earth, with constellations and deep sky objects.

Blending visual and technical accuracy, *Dance* is for everyone.

Accompanied by an acclaimed manual and tutorial tours of the sky and solar system, *Dance of the Planets* has become the standard wherever there is abiding interest in astronomy.

Rated *Best Overall Package* and *Editors Choice*, **Astronomy Now** (UK) review of thirteen astronomy software packages, August 1992

Finalist, **Discover** Magazine's *1992 Awards for Technological Innovation*

Richard Berry, **Astronomy** Editor in Chief, August 1991... "most imaginative and imagination–inspiring software I have yet seen running on a PC..."

John Mosley, **Sky & Telescope** June 1992 review..."it remains an order of magnitude better than any other solar system simulator. It's a must have."

New

The Observer's Companion

An on-line calculating almanac to find past and future eclipses, conjunctions, occultations, risings, settings, meteor showers, lunar circumstances, and much more. A welcomed companion to the powerful *Dance* simulation capabilities.

Limited Time Offer

The Observer's Companion is being introduced at no extra cost when ordered with *Dance of the Planets* (a $30 value).

New

Stars8.0 Extension

Enhance *Dance* with additional stars to 8th magnitude for a total of 45,000. Includes click-on-stars feature to bring up information boxes and enhanced star chart hardcopy. No other software has stars faster or as realistic as *Dance* with *Stars8.0 Extention*. A $35 option when ordered with *Dance of the Planets*.

New

Windows-Ready

Dance of the Planets operates smoothly as a DOS application in Windows 3.0/3.1, and is configured for uncompromised performance. Just click on the handsome *Dance* icon.

ARC Support

Registered users—call or write for update privileges.

IBM compatible, 640 k, EGA/VGA, HD, Math coprocessor recommended.
$195 + s&h.
Literature, demo available.
1-303-667-1168
FAX: 1-303-667-1105

arc SCIENCE SIMULATIONS

DANCE OF THE PLANETS™

Order Today, Call 1-800-SKY-1642

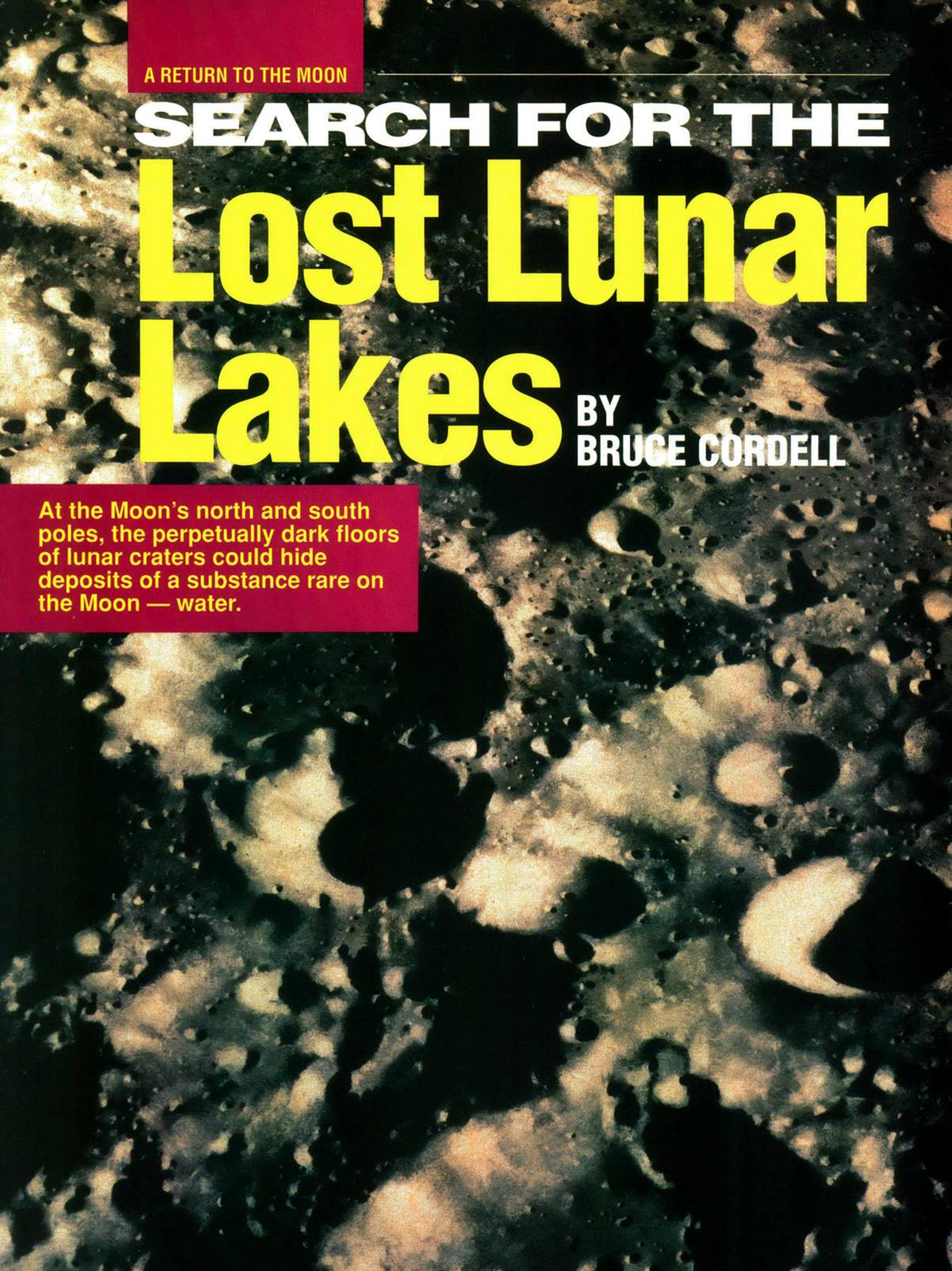
P.O. Box 1955A • Loveland, CO 80539

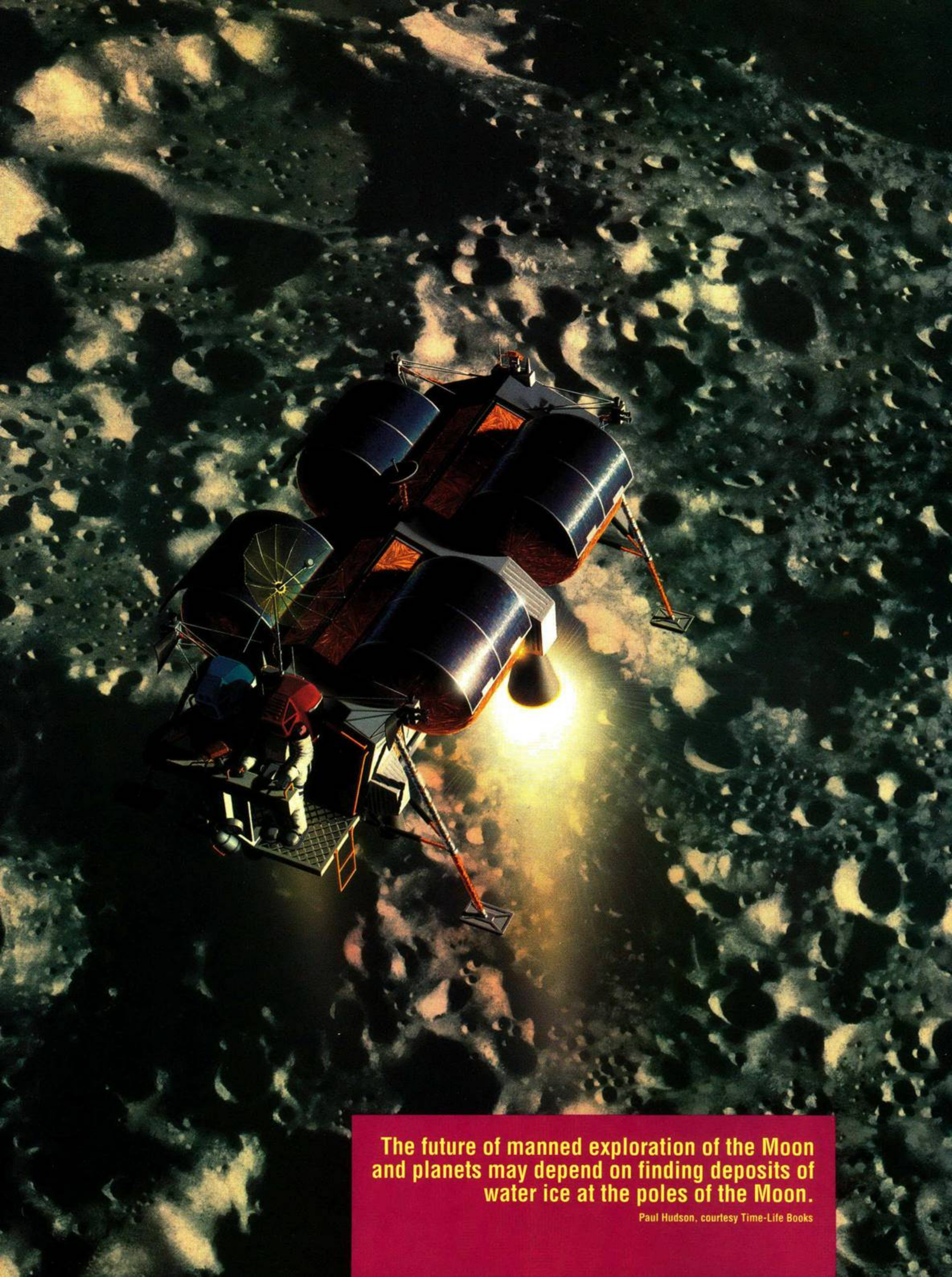
A RETURN TO THE MOON

SEARCH FOR THE Lost Lunar Lakes

BY BRUCE CORDELL

At the Moon's north and south poles, the perpetually dark floors of lunar craters could hide deposits of a substance rare on the Moon — water.





The future of manned exploration of the Moon and planets may depend on finding deposits of water ice at the poles of the Moon.

Paul Hudson, courtesy Time-Life Books

An adventure worthy of Indiana Jones is taking center stage in the world of space exploration — the search for the lost "lakes" of the Moon. The outcome of the search will affect how we conduct manned exploration of the planets in the coming decades.

If the lakes are found, the Moon becomes the initial goal for human space exploration, even settlement. If they aren't, NASA could launch a direct-to-Mars movement that might leave the desiccated Moon in the backwaters of space exploration. NASA's current interest in return missions to the Moon spotlights the possibility that water brought to the Moon by the impacts of comets might exist at the lunar poles.

Seekers of the Lost Lakes

In 1610 Galileo thought he had discovered lunar lakes. And based on the lunar place names — such as the Sea of Tranquillity and the Ocean of Storms — other early explorers of the Moon concurred. Although the lunar maria were soon proven to be dry beds of lava, the optimism for finding water everywhere on the Moon continued until the first Apollo landings more than 20 years ago. Early plans for lunar bases published in the 1960s suggested that rocket propellants might be produced from moisture expected in the lunar soil. Mission planners hoped then (and as we shall see, still hope) that not having to import water from Earth would dramatically reduce the cost of lunar operations and facilities.

But the Apollo verdict was "no water." All the Apollo lunar samples were completely dry except for a few "rusty" rocks brought back by Apollo 16 that were probably contaminated by water in Earth's atmosphere. Indeed, we have no direct evidence for water deposits anywhere on the Moon. Nevertheless, the hopes of finding water still remain.

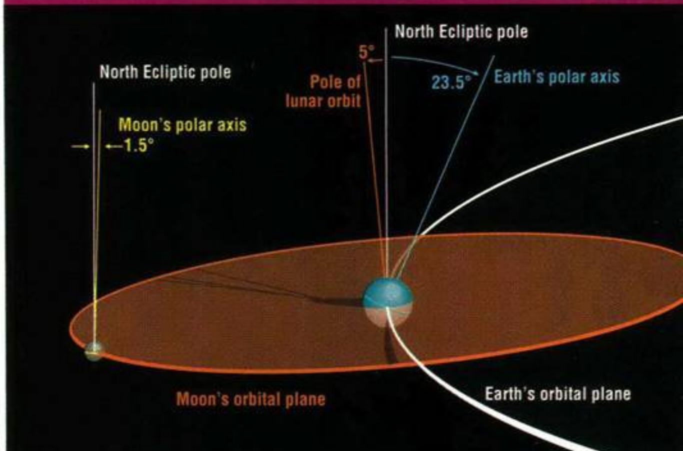
Recent ideas for a moist Moon originated back in 1837, when German astronomer Johann Mädler explained the significance of Mountains of Eternal Light at the Moon's north pole. Most locations on the Moon receive 14.75 days of sunlight in each 29.5-day cycle of phases, but mountains at or near the poles receive nearly continuous sunlight because the Moon's equator is inclined only $1\frac{1}{2}$ degrees to the plane of the solar system. This also implies there are crater floors or valleys that never see the Sun and must be extremely cold. These polar cold traps might capture gases such as water vapor and retain them as ices for millions of years or longer.

Could lost lakes be hiding in the Moon's polar regions? In 1961, Kenneth Watson, Bruce Murray, and Harrison Brown of the California Institute of Technology said yes. They proposed mechanisms that showed how cold traps could capture gases such as water vapor released from deep within the Moon. For cold-trap temperatures of 100 K or less (–173° C), their model predicted water could remain frozen at the lunar poles for the Moon's entire lifetime.

Ten years after the first Apollo lunar landings, James Arnold of the University of California, San Diego, commented that like the lunar lakes, "an important paper by Watson, Murray, and Brown (1961) seems to have been lost."

Arnold reexamined Watson, Murray, and Brown's 18-year-old study in light of the flood of data from Apollo. The original study had assumed the only source of lunar water was the Moon itself, from gases vented from the interior. Arnold proposed a second source of water: the impact of water-rich meteors and icy comets.

The south pole and the north pole, which is seen here in a 1967 image from Lunar Orbiter 4, are illuminated by sunlight at a very shallow angle. As a result, the lunar poles harbor permanently shadowed craters that could trap ice for millions of years.



There are no "seasons" on the Moon because the Moon's rotation axis is tipped by only 1.5°. Sunlight grazes the polar regions at the same low angle throughout the year, producing areas of permanent shadow.

ASTRONOMY: Thomas L. Hunt

Raiders of the Lost Lakes

Arnold also pointed out ways that ices trapped on the Moon could be eroded. For example, both ultraviolet radiation and the impact of atomic particles from the solar wind could destroy water molecules by splitting them into their constituent hydrogen and oxygen atoms. These would then escape from the Moon.

Despite uncertainties about how well any of the water sources and destruction mechanisms might work, Arnold concluded that polar ice deposits probably exist. He also suggested that so-called gardening of the lunar soil by the constant impact of meteoroids might mix the water through the regolith to a depth of 2 meters and produce a typical concentration by weight of 1 to 10 percent.

That's the optimistic estimate. Other researchers found the erosion mechanisms might be more effective than Arnold had estimated. Experiments conducted by Louis Lanzerotti of Bell Laboratories revealed that unlike sunlight, which shines from one direction and forms shadows, solar wind particles bombard the Moon from all directions and rain down on even permanently shadowed regions.

Lanzerotti estimates that interplanetary space, including that surrounding the Moon, is filled with

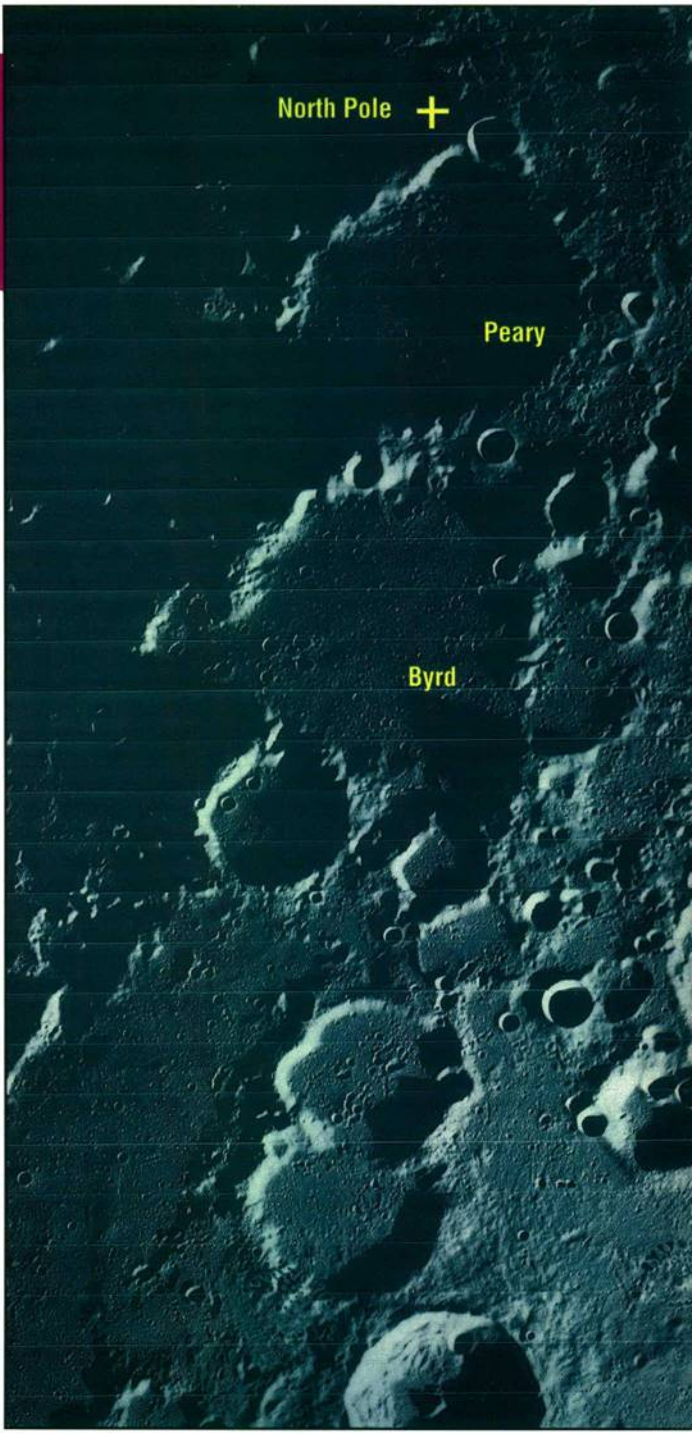
NASA

energetic particles from solar flares about one-third of the time. Also, for a few days each month the Moon passes through the Earth's magnetic tail and is exposed to charged particles (mostly hydrogen ions) trapped in the tail. All these particles might reach any portion of a polar cold trap and erode exposed frozen water. According to Lanzerotti, water would be removed as fast as it was deposited. Gardening of the soil by the spray from local meteor impacts would offer little protection.

There's more bad news for water-seekers. Richard Hodges, Jr., of the University of Texas at Dallas, finds that bowl-shaped craters with diameters less than 20 kilometers produce most of the permanently shadowed areas at the Moon's high latitudes. But surprisingly, his calculations show that bowl-shaped craters do not provide significant storage areas for polar water. This is because their permanently shadowed floors are heated to above 100 K (except at latitudes above 85 degrees) by infrared radiation from their surrounding walls.

Flat-floored craters are another matter. Hodges' analysis shows that flat-floor craters above latitudes of 80 degrees have significant areas with cold-trap potential. However, he concluded that the total surface area on the Moon cold enough to provide permanent water traps is much less than that estimated by Arnold and Watson. But because large amounts of water can be held on the surfaces of soil grains, Hodges still agreed with Arnold's tentative conclusion — a sizable reservoir of water could be stored near the lunar poles, if there is an adequate supply of water.

Before Galileo, our last glimpses of the Moon's north pole (right) and south pole (far right) were 26 years ago in these shadowy images from Lunar Orbiter 4.



Springs of the Lost Lakes

Astronomers now think the most probable sources for lunar lakes are the impacts of comets and eruptions of gases from the Moon's underlying mantle. Most of the lunar outgassing should have occurred very early in lunar history, when the Moon was much hotter and molten regions were closer to the surface. When volcanic gases, including water, encountered the polar regions they should have been trapped there. Could 4-billion-year-old lunar lakes have survived to the present?

S. K. Runcorn of the University of Newcastle upon Tyne has suggested that the Moon's rotational poles wandered about early in the Moon's history. The force of the impacts that created the large basins near the equator could have shifted the entire outer skin of the Moon around. The crust could have slipped away from the Moon's rotation pole by as much as 50 degrees of latitude. Regions previously near the poles and permanently shadowed would be relocated closer to the equator. Any ices frozen in the soil would be lost.

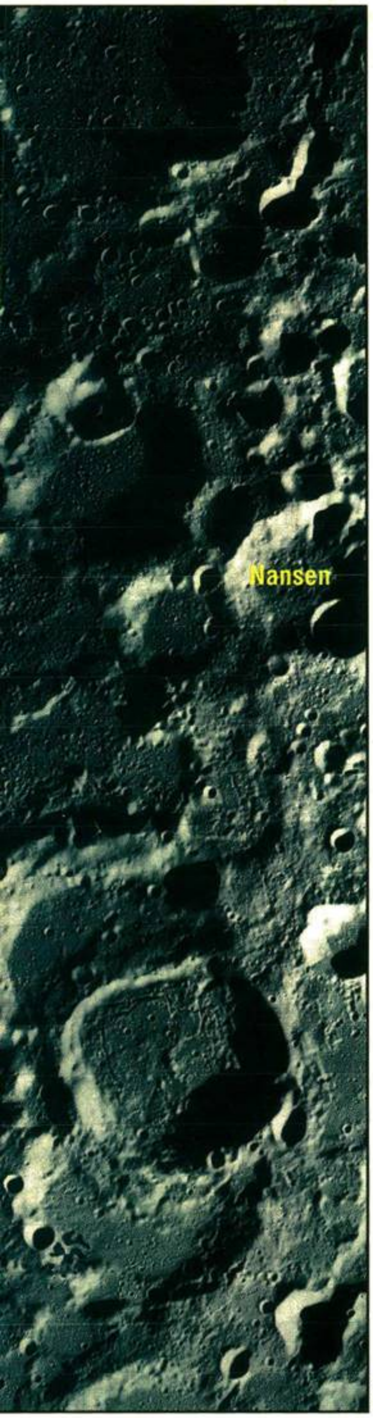
Runcorn bases this model on the observed orientations of ancient magnetized lunar rocks, which seem to document three such monumental shifts during lunar history. However, attempts by others to confirm Runcorn's model have been inconclusive. If Runcorn is correct, the crust didn't settle into its present orientation relative to the rotation axis of the Moon until about 3.2 billion years ago. Any lunar or cometary gases trapped at the poles prior to 3.2 billion years ago would have been lost due to polar wandering and exposure to the Sun.

So if we want to find lunar lakes we need to look for sources of water that have been active since that time. Volcanic activity is one source but a controversial one. As far back as the late 18th century, William Herschel observed several localized red glows and suggested they were volcanoes. Other observers have reported strange glows on the Moon, which have become known as Lunar Transient Phenomena, or LTPs.

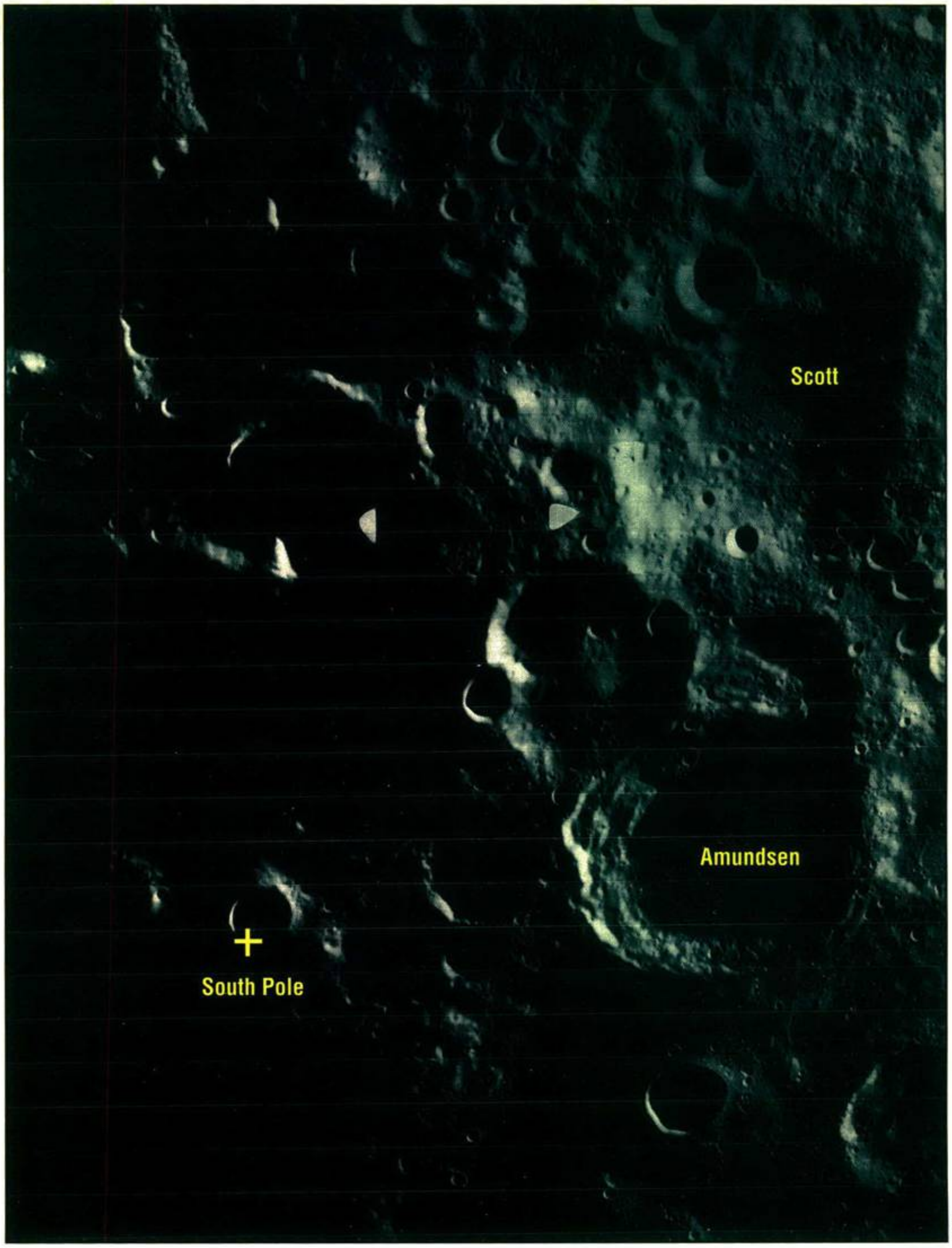
Astronomers have now catalogued over 1,200 LTP observations, some made recently by reliable observers. A spectrum taken in 1958 by Russian astronomer Nikolai Kozyrev documented an event in the crater Alphonsus that suggested gas emissions. LTPs have been reported at several sites, although 40 percent of all LTPs occur near the crater Aristarchus. The glows seem to be correlated with deep and shallow moonquakes. All appear related to tides raised by the gravity of Earth. Although the cause of LTPs is uncertain, it is possible they are evidence of the release of volcanic gases from deep within the Moon. Even so, their contribution to the lost lunar lakes is probably minor relative to the contribution of comets.

Comets appear to be the most likely source of lunar polar waters. A comet can deliver as much water in one impact as lunar outgassing or meteors can in billions of years. A comet impact is rapid and produces an appreciable but temporary atmosphere around the Moon which might then condense at the poles. Arnold calculates that comets may have delivered as much as 100 million million kilograms of water to the lunar surface over the last 2 billion years.

There is growing evidence for swarms of comets that occasionally invade the inner solar system from a distant reservoir of comets called the Oort Cloud. On Earth, the signatures of alleged comet storms include mass extinctions, impact crater clusters, and reversals in the geomagnetic field. Scott Tremaine and his colleagues at the University of Toronto have suggested that intense comet showers occur at random times in response to close encounters with nearby passing stars. Others think that comet showers are regular occurrences triggered by an as yet unseen companion star orbiting the Sun.



NASA



NASA

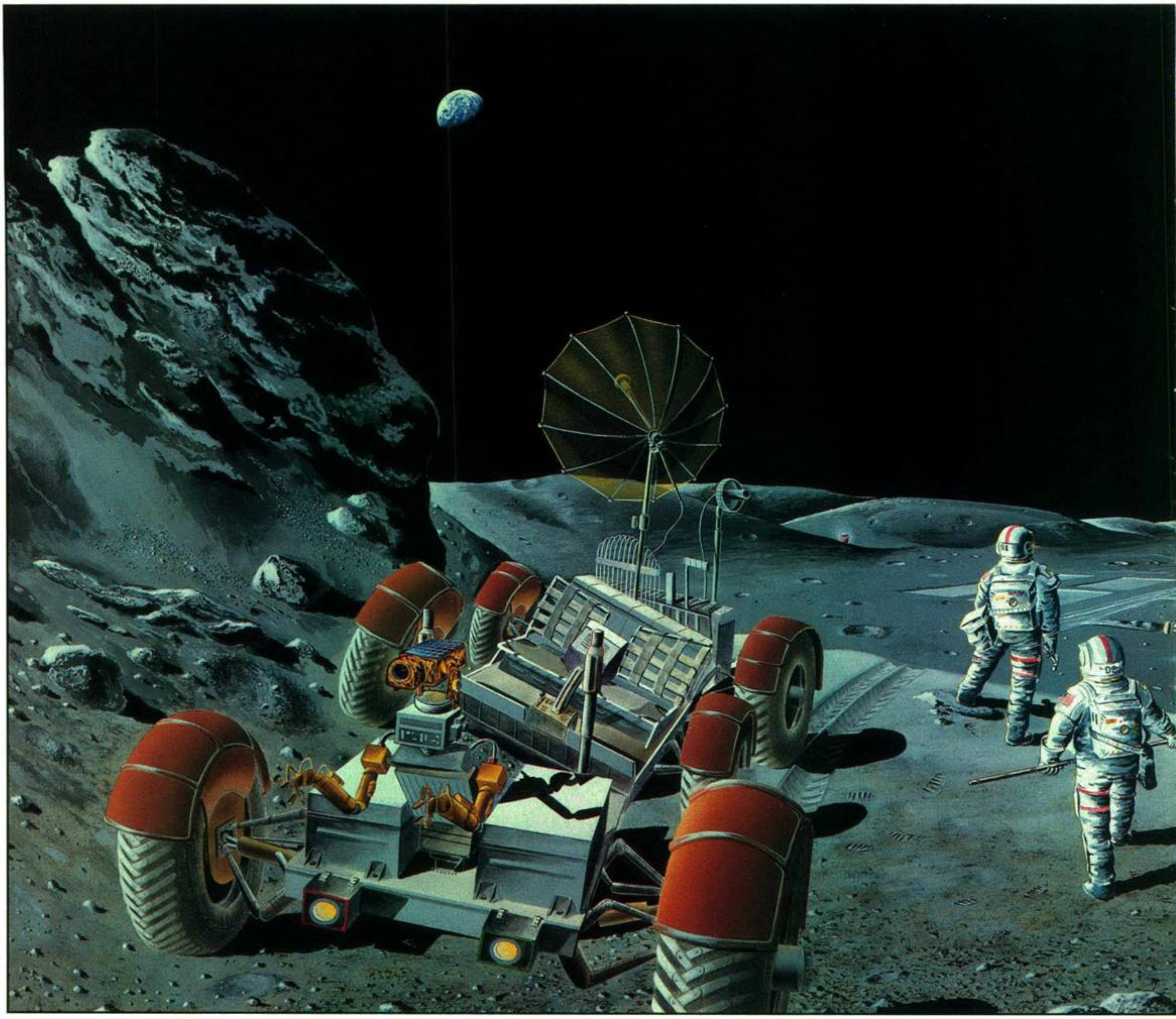
In any case, the "rain" from a comet storm could be intense — up to 10,000 comets per year swooping near the Sun. According to one model, the most recent cometary assault ended only 13 million years ago. Any resulting comet-derived polar ices on the Moon that were gardened into the regolith should still be there.

A Snowball's Chance

The prospect for lunar lakes received a boost in August 1991 when astronomers used radar to discover what may be a water ice cap at Mercury's north pole — remarkable on a planet where midday temperatures exceed 800 K, over 400 K hotter than the Moon.

Martin Slade of the Jet Propulsion Laboratory and his colleagues have converted the radar data into images of Mercury's surface. (See AstroNews, February 1992.) Without a doubt, a large, radar-bright feature in the shape of a polar cap adorns the north pole. Based on the radar appearance of Mars' south polar ice cap, the radar astronomers suggest the Mercurian cap is also composed of water ice. Critics counter by offering metallic evaporites such as tin, copper, and zinc as candidates for Mercury's cap. They believe an ice cap on Mercury is as likely as the proverbial "snowball in hell."

As with the Moon, ideas about the formation of Mercury's ice cap focus on permanently shadowed craters in the polar regions. Calculations suggest that polar temperatures may dip to 125 K or even lower inside crater walls on Mercury, assuming more than 50 percent of the sunlight is reflected from the surface. Due to Mercury's elliptical orbit and the lock between the length of its year and its day (Mercury's year is 1.5



times as long as its day), the Mercurian cap should be oblong, about 100 by 400 kilometers.

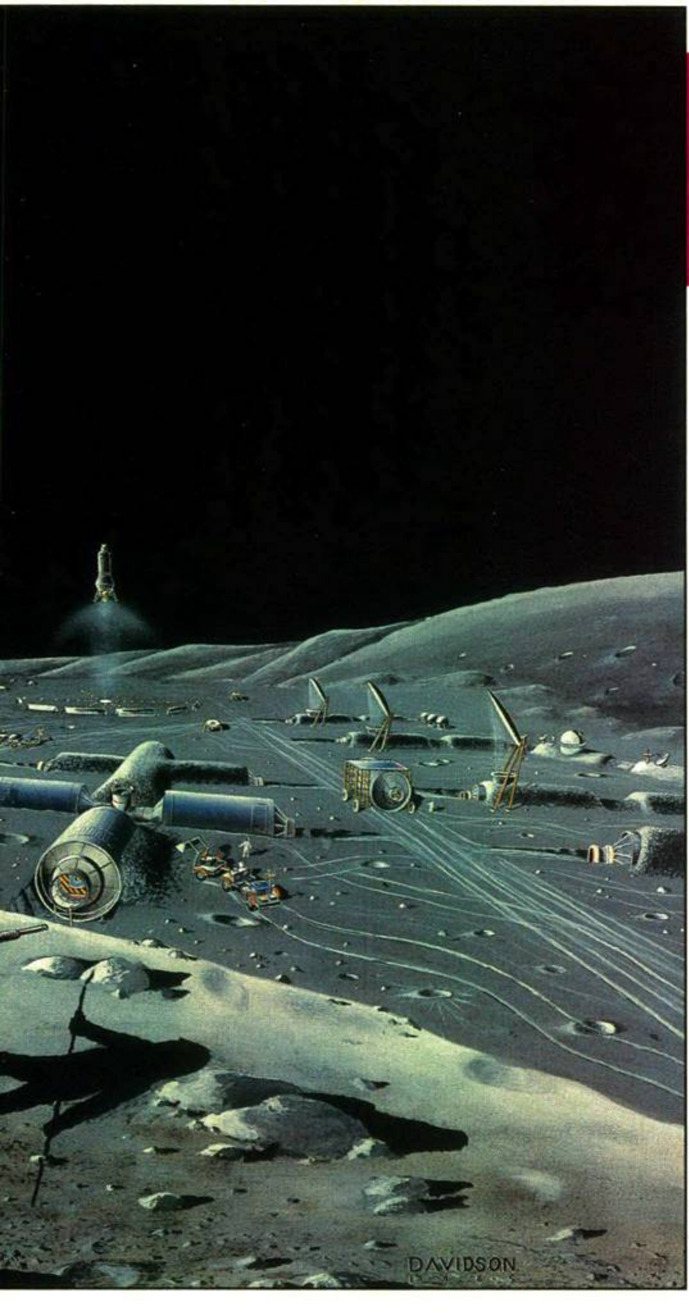
Over the last few billion years, Mercury would have been subjected to the same water sources and erosion mechanisms as the Moon. But the higher temperatures and increased effects of solar wind particles should have made Mercury a less likely place to find polar caps. If Mercury does have water ice caps, it's possible the Moon has them too.

Expeditions to the Lost Lakes

The only way to settle the question of whether the Moon is wet or dry is to go there with a space probe dedicated to the task. The last spacecraft to explore the Moon in detail were the manned Apollo missions and Soviet Lunokhod robot rovers of the 1960s and early '70s. Since then, despite its proximity — or perhaps because of it — the Moon has received few visitors. And fewer still have ever explored the north or south poles of the Moon. The only spacecraft to orbit over the poles were the unmanned Lunar Orbiter 4 and 5 space probes in 1967. Their missions were simple: photograph the Moon so astronomers could produce detailed maps in preparation for the Apollo landings. The Lunar Orbiters had no instruments for analyzing the lunar surface, let alone for finding hidden water deposits.

In December 1990 the Jupiter-bound Galileo probe flew past Earth and the Moon and photographed the poorly observed lunar farside, the first spacecraft to do so since the early 1970s. (See March 1991 ASTRONOMY.) Then again, just a few weeks ago Galileo returned for another gravity-assist maneuver before heading off to the outer solar system. This time Galileo flew over the Moon's north pole, giving us our first look at that mysterious region since the days of the Lunar Orbiters.

Although Galileo bristles with sensors and cameras, its instruments are optimized for exploring the atmosphere of Jupiter. Galileo lacks the one instrument most needed to search for subsurface lunar ice — a gamma-ray spectrometer. As it passes above a planet,



Dennis Davidson/NASA

Sites near the lunar poles with deposits of ice may become the choice locations for manned lunar bases in the 21st century.

such an instrument can detect neutrons emitted from the soil below. Underground ice deposits slow down these neutrons, a telltale sign a gamma-ray spectrometer can detect. So while Galileo will certainly tell us about the mineral composition of the Moon's polar regions, it is unable to find direct evidence for any lost lakes that may be present.

The craft that would have settled the question was a mission called Lunar Observer, essentially a twin to the Mars Observer probe now on its way to the Red Planet. Mars Observer has a gamma-ray spectrometer, as would its lunar counterpart. But Lunar Observer never made it off the drawing boards.

As a lower-cost alternative, NASA proposed two small Lunar Scout missions for the late 1990s. One would have been dedicated to mapping the gravitational field of the Moon and measuring the height of lunar features. The other orbiter would have mapped the mineral and soil composition with cameras sensitive to different parts of the spectrum as well as with an all-important gamma-ray spectrometer. Both missions were part of NASA's Space Exploration Initiative, a program aimed at returning humans to the Moon and on to Mars. Congress slashed funds for the Initiative and with them went the Lunar Scouts.

One lunar mission is in the works, however — one that few people have heard of. It comes not from NASA but from the Department of Defense. In January 1994 the DoD will launch a small satellite toward the Moon called the Integrated Sensor Experiment (ISE). The mission is part of the Strategic Defense Initiative or "star wars" program and is designed to test new high-tech cameras in the environment of space. The small spacecraft contains three miniaturized camera systems, one sensitive to long-wavelength infrared, one for short-wavelength infrared, and one for visible and ultraviolet light. Department of Defense officials invited NASA scientists to work with them on the ISE mission (which the NASA astronomers have oddly dubbed "Clementine") to ensure ISE returns useful science.

For two months in early 1994, ISE will orbit the Moon at a distance of 400 to 3,000 kilometers. It will then leave lunar orbit and head off for an August 1994 flyby of the asteroid 1620 Geographos, one of the growing number of asteroids astronomers are discovering whose orbits approach Earth. The ISE probe will fly to within 100 kilometers of Geographos, giving us our first close look at a near-Earth asteroid.

During its lunar sojourn ISE's cameras will map the Moon at various wavelengths to a resolution of a few hundred meters. Like Galileo's instruments, ISE's cameras should tell astronomers about the mineral composition of the Moon but, unfortunately, they are unable to directly detect water. But with all other plans for lunar exploration by NASA on hold, missions such as Galileo's flyby and ISE are the only opportunities we have in the near future for finding the Moon's lost lakes.

If we ever do find water on the Moon, the icy locations may become the best sites for manned lunar bases. The water could be extracted from the soil using microwave ovens to heat the soil and release the water. Once free, the water would be used for life support systems and for manufacturing rocket fuel. In addition, the poles provide a useful combination of continuous sunlight for power generation and permanent darkness for keeping rocket propellants, ice, and other essentials in natural cold storage.

Certainly the advantages of a polar site make the Moon's north and south poles very attractive locations for future manned landings. Perhaps in the next century, we'll see the first human settlements on another world built on the shores of the lost lakes of the Moon. □

Bruce Cordell is a planetary scientist involved with planning advanced missions to the Moon and Mars.

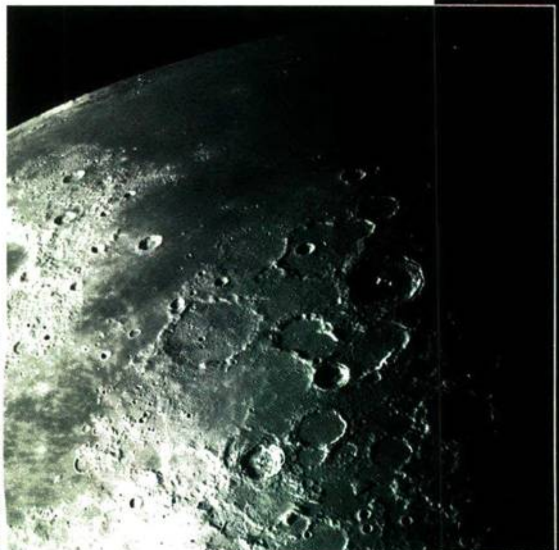
GALILEO RETURNS to Earth and the Moon

Galileo's second flyby of Earth did much more than just boost the spacecraft on its way to Jupiter.

by Robert Burnham

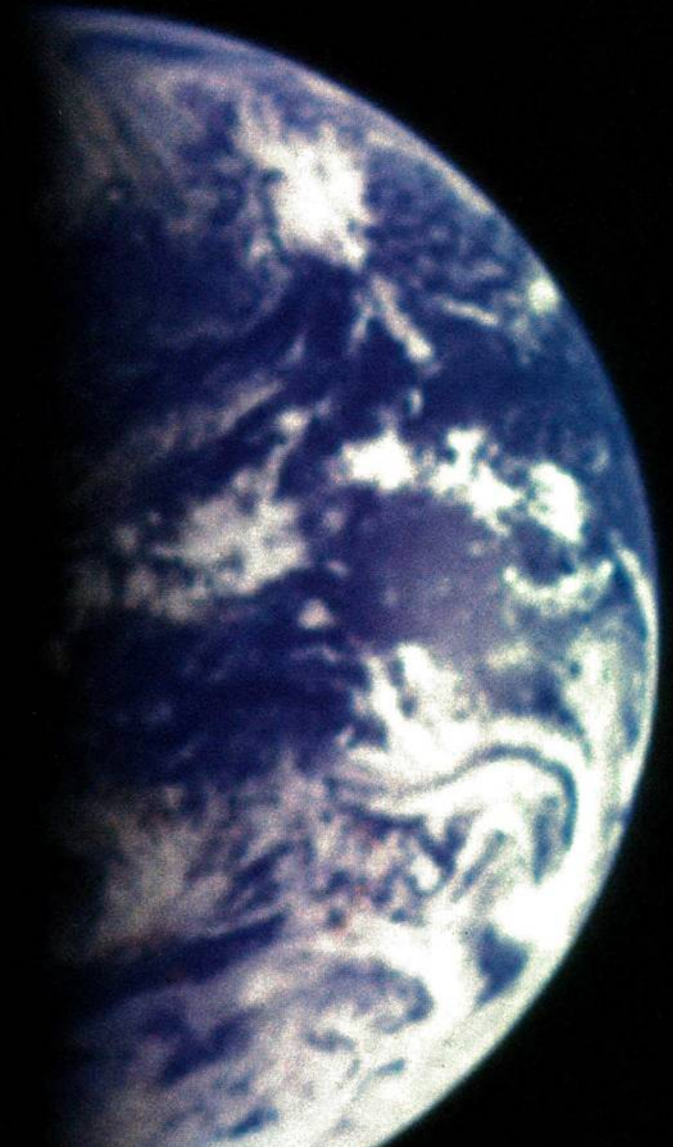
On December 8, 1992 — two years after its previous pass by the Earth and Moon — the Galileo spacecraft paid a return visit to pick up a few needed kilometers per second of velocity. On its 23-hour dash across the Earth-Moon system, Galileo imaged the north polar region of the Moon, and on its way out, the spacecraft looked back to make a spectacular movie of the Moon passing the whirling Earth.

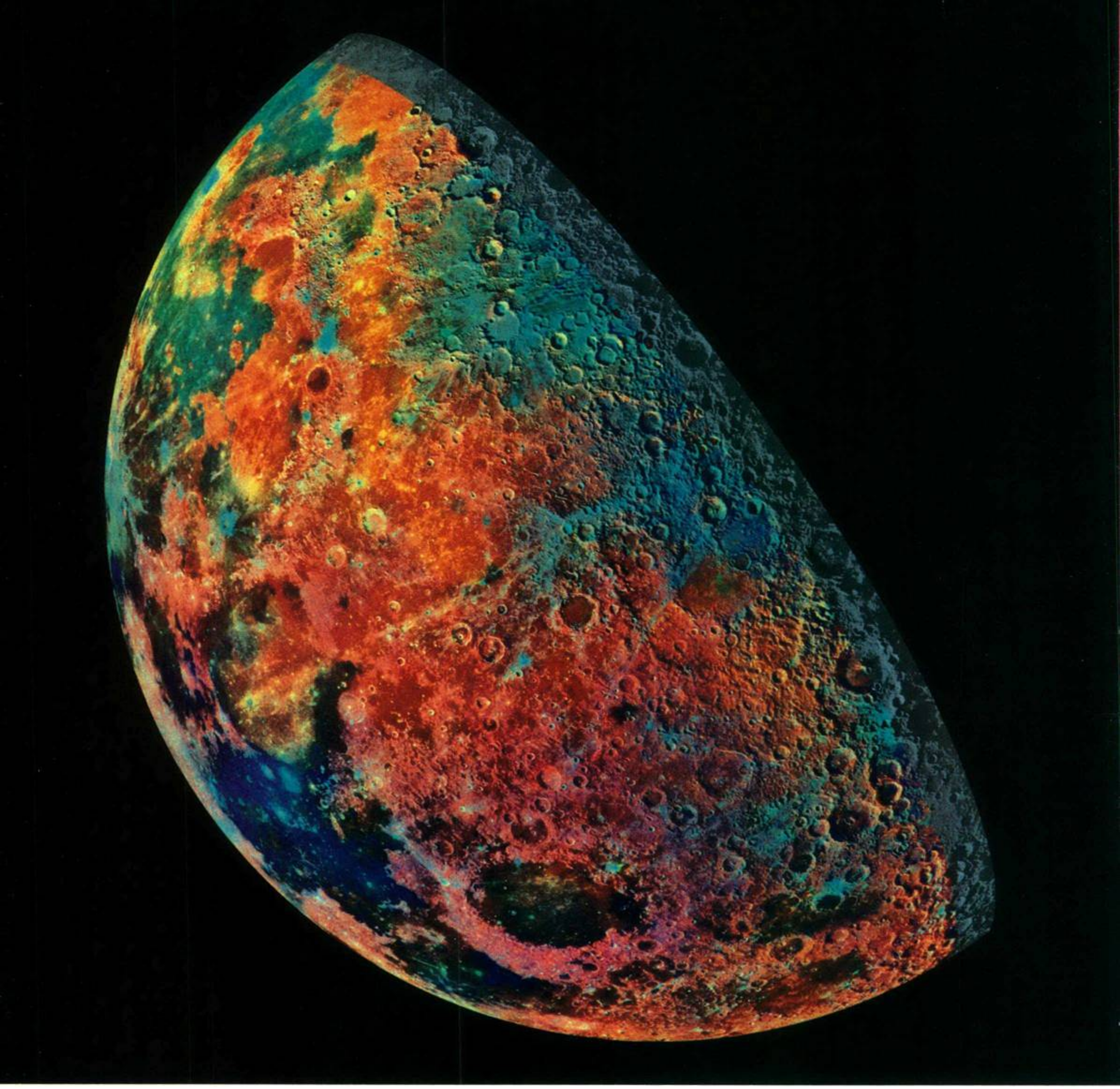
The encounter with the Moon provided a look at the Moon's north pole, a region hard to view from Earth and little seen by previous spacecraft. Scientists explored two



EARTH AND MOON POSE SERENELY against the black of space in this view taken by Galileo as it departed Earth for the last time. Below: Looking southwest across Mare Frigoris.

All images courtesy of NASA/JPL





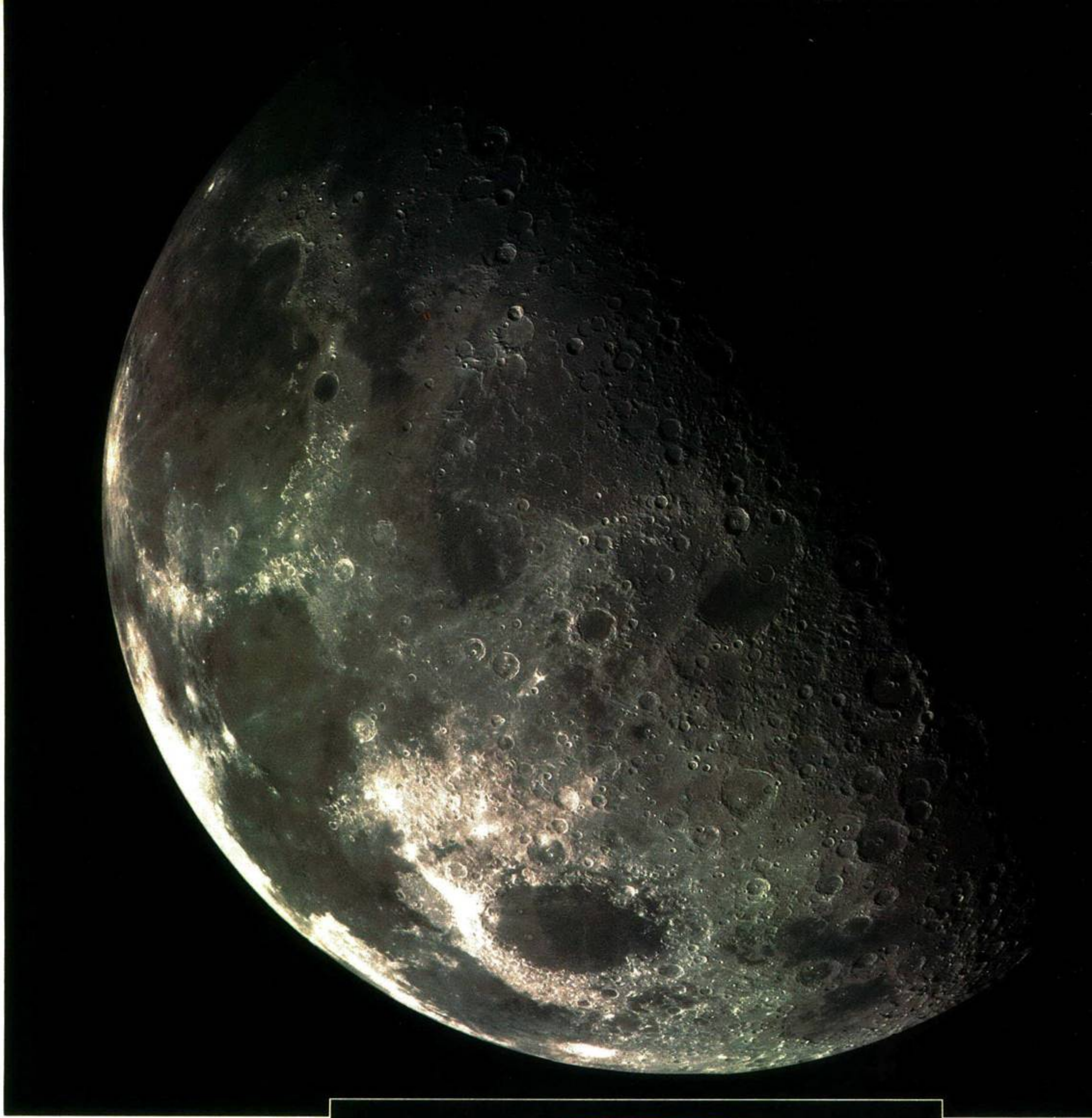
ringed impact basins there and found clear effects of the gigantic Imbrium impact, which left its marks on much of the Moon's nearside hemisphere.

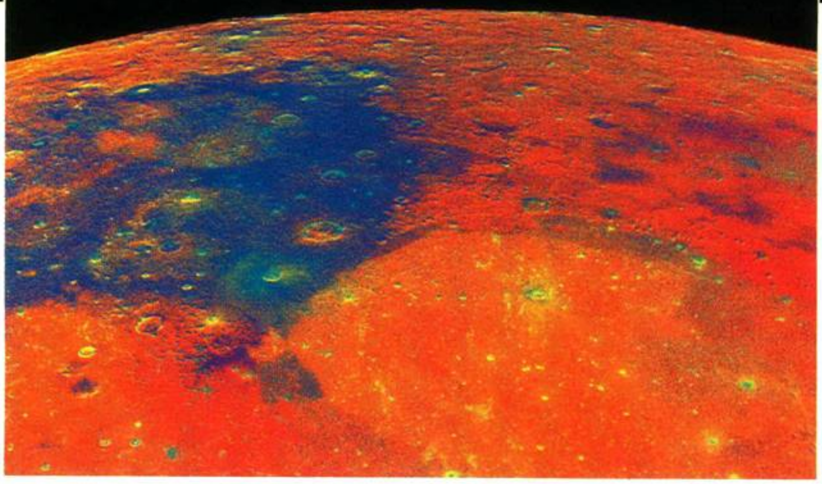
Scientists are eagerly anticipating comparing Galileo's multispectral images with rock samples from the U.S. Apollo and Soviet Luna missions. This will give invaluable "ground truth" so scientists can deduce the composition of surface areas from the remote-sensing data.

Already the flyby has offered some surprises. In particular, the surface materials lying north of Mare Frigoris contain rocks that appear similar to mare basalts. Galileo's Near Infrared Mapping Spectrometer (NIMS) took images in spectral bands that revealed the mineral composition of the surface rocks. These showed a high content of the minerals olivine and pyroxene, common in the dark lavas of the maria. Scientists had not expected to see this in the polar rocks because these were believed to have formed before mare volcanism began. They termed this new material "cryptomare." A related NIMS finding is that the lunar polar materials are much more diverse in composition than previously suspected.

Another puzzle piece fell into place with the Mare Humboldtianum basin. This is a double-ring crater whose inner ring is filled with dark material. Scientists can now examine the extent of the infill and view clearly the angular outlines of the rings themselves. The polygonal outline of the feature appears to be a result of the basin's forming on a landscape already heavily cratered.

West from Humboldtianum, Galileo's images detailed the extent of sculpturing by the impact that created the Mare Imbrium basin. Some Imbrian sculpturing is familiar to ev-

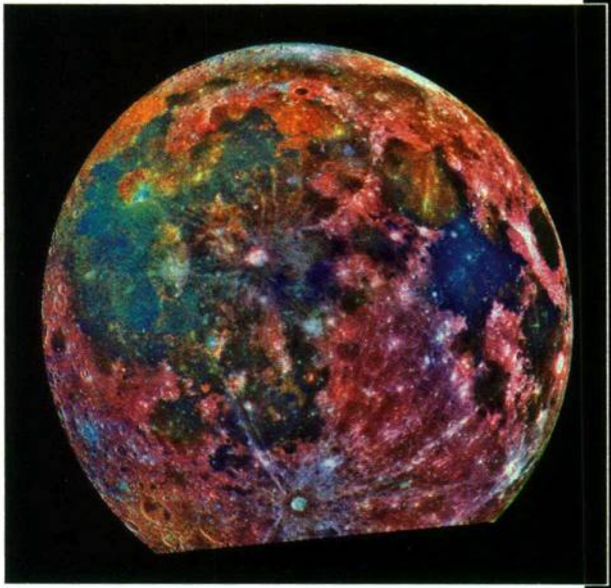


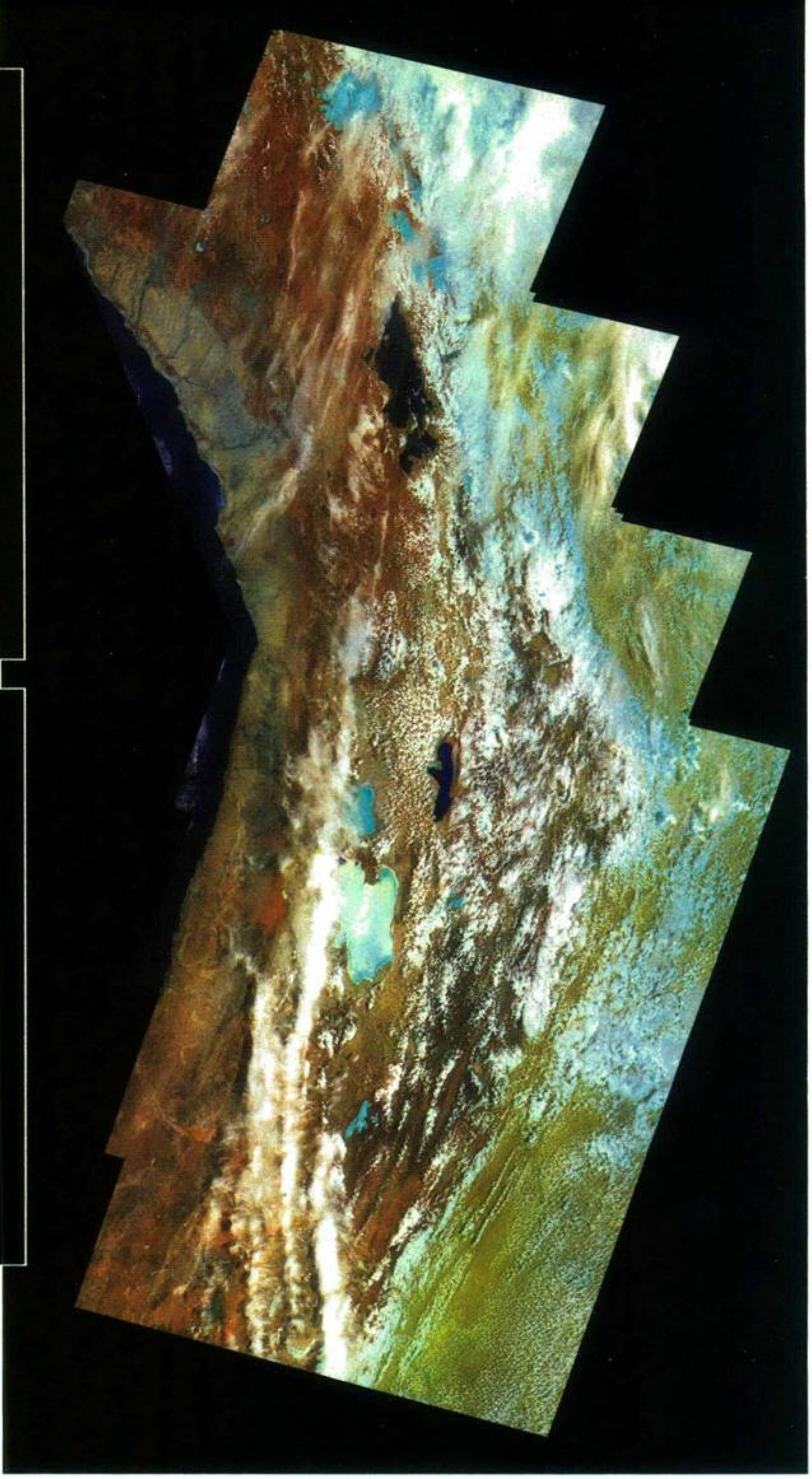


THE TOP OF THE MOON is a geological wonderland as mapped in false color by Galileo's instruments. Right: You are looking southwest over Mare Serenitatis and Tranquillitatis.

ery telescope owner: the lineations on the Apennine mountains southeast of Mare Imbrium. Similar gouges also exist in the region northwest of Mare Imbrium. These aligned valleys were carved by debris flying from the impact. Scientists hope to use the sculpturing to date craters in this little-understood part of the Moon.

In several places the NIMS images





TAWNY DESERTS mark Egypt and Arabia (far right), while thin clouds drape the central Andes Mountains and Lakes Titicaca and Poopo (near right). Above: A "First Quarter Earth" and a Full (false-color) Moon, seen as Galileo sped past and set course for Jupiter.

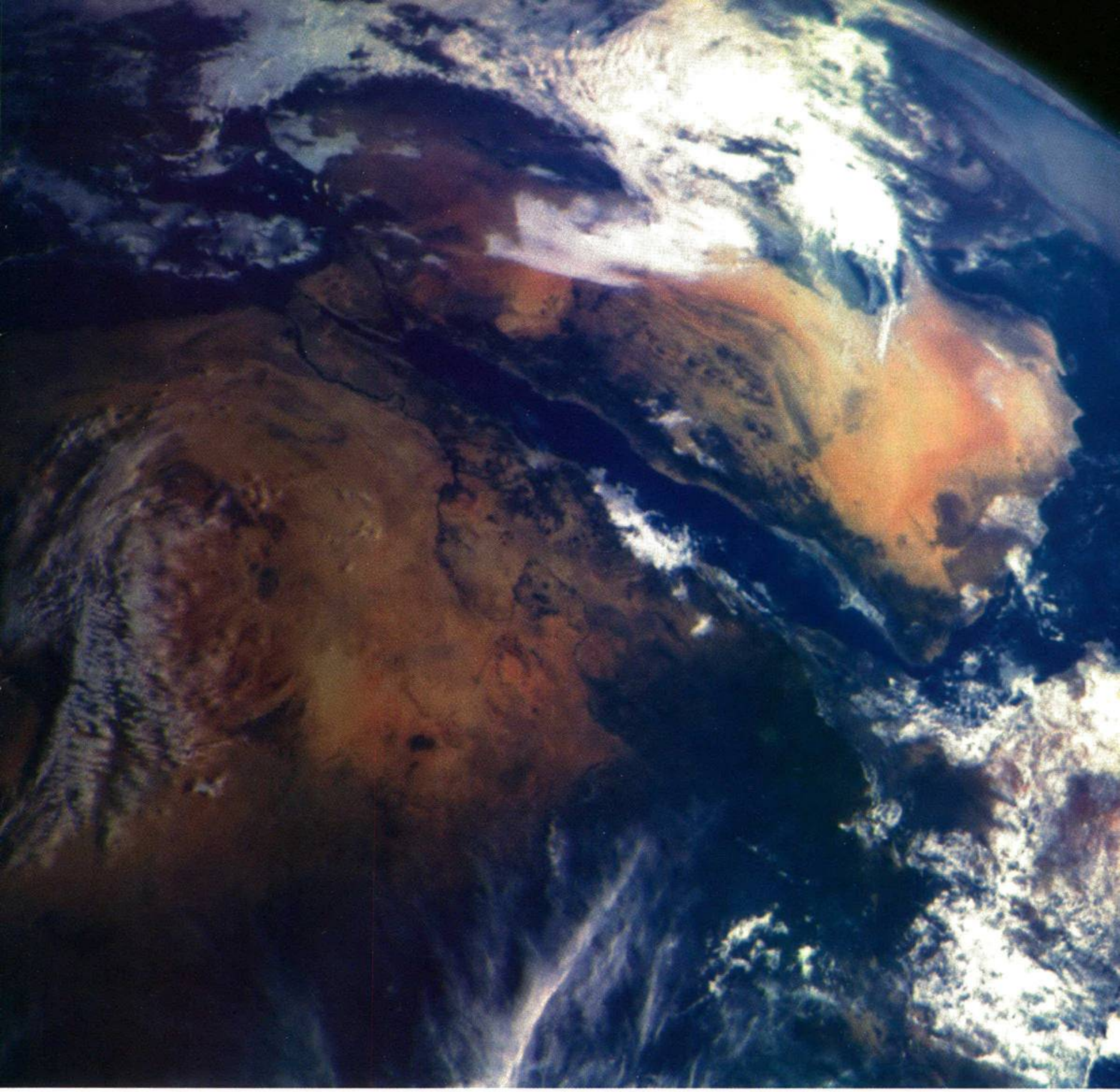
show where small, recent craters have punched through the surface materials and thrown out aprons of debris from the underlying layers. Working from crater sizes, scientists estimate the surface layers are several hundred meters thick. This is large by terrestrial standards, but appears to be common on the Moon. In addition, the flow patterns suggest the lava sheets were unusually "runny" — about as fluid as motor oil.

In addition to the Moon, Galileo also gave new views of our home planet. Mission scientists looked for clouds in the stratosphere over the South Pole. This is where a large hole in the ozone layer opens up each southern spring. Galileo's NIMS imager identified a large cloud made of ice crystals that could contribute to the ozone destruction by providing a catalyst for the chemical reactions that destroy ozone. The cloud was visible later in the season than any ever seen before.

The Ultraviolet Spectrometer looked for atomic hydrogen evaporating from the top of the atmosphere. The hydrogen originates in water vapor lifted to the uppermost regions of the atmosphere, where sunlight splits it into oxygen and hysrogen. The light hydrogen atoms escape to form a tenuous, teardrop-shaped cloud that surrounds Earth and extends into space beyond the Moon's orbit. Although scientists had long known of the cloud's existence, it had never been imaged .

Galileo made its closest approach to Earth (at 304 km altitude) over the South Atlantic Ocean. But unlike the last encounter, when Galileo viewed *a nearly Full Earth on its way out*, this time the craft departed in the 6 a.m. direction, ahead of Earth in its orbit.

Shortly after closest approach to



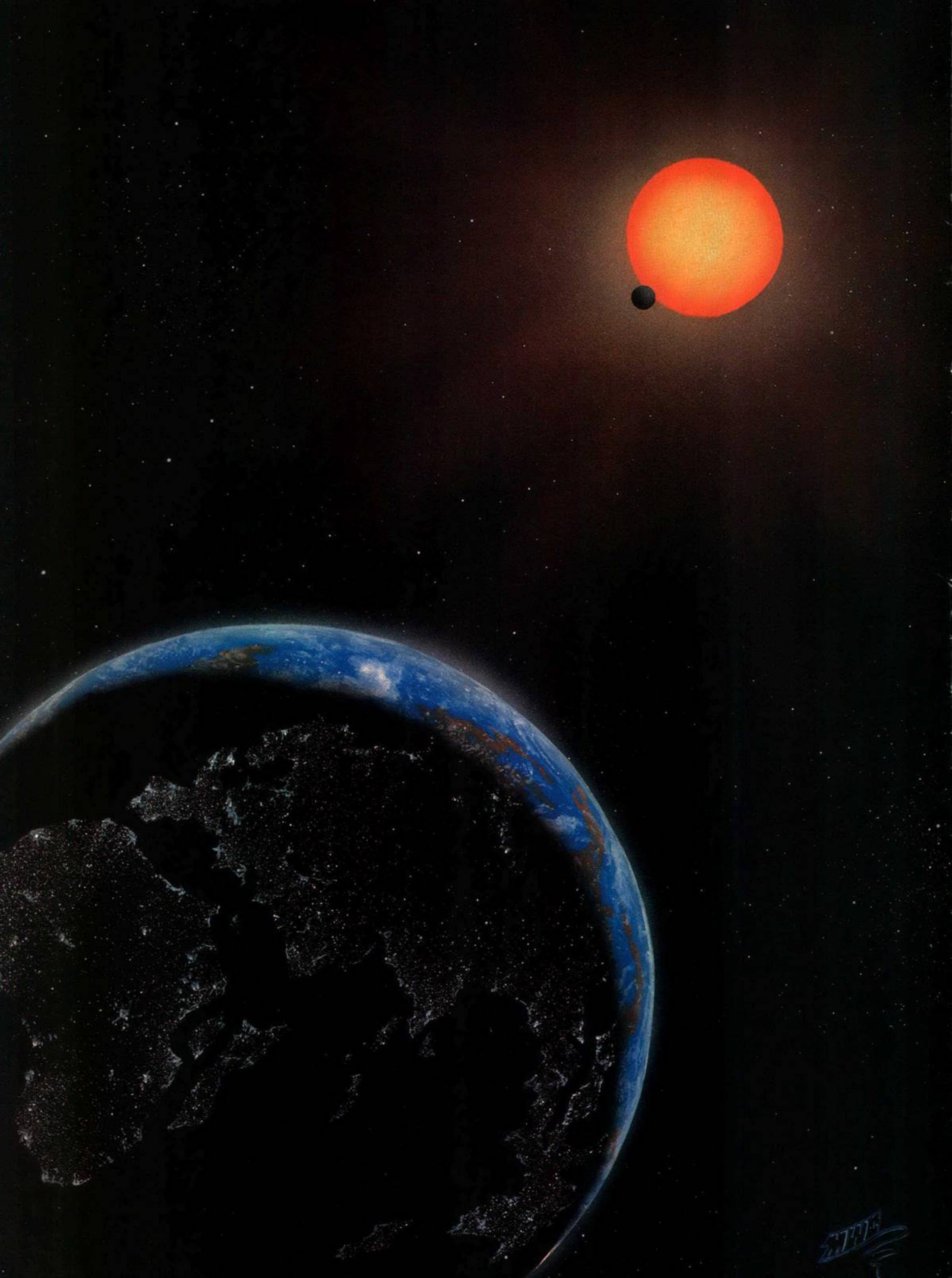
Earth, Galileo aimed its sensors toward South America, focusing specifically on the Andes Mountains near Lake Titicaca. Scientists plan to compare the Galileo images with the known geology of the region. This will help calibrate Galileo's detectors for use at Jupiter and its moons.

Galileo's departure marks a turning point. In a literal sense, Earth's gravity bent its course and added a 3.7 km/second boost to the craft's velocity. But for project scientists, the encounter also means that Galileo is finally bound for the outer solar system. Their attention is now focusing on the rest of the flight — Galileo's *real* mission.

As we go to press, the high-gain antenna remains stuck, half-unfurled. Project engineers will try to force the antenna open by pulsing the drive motor rapidly hundreds of times. But if the "motor-hammer" doesn't work, Galileo will have to fly its mission using the low-gain antenna for communication with Earth.

This would mean reduced data from Jupiter. However, project staff believe they can retrieve about 70 percent of the original mission by clever programming. The big losses occur in imaging, where about 3,000 photos replace the over 50,000 planned, and in studies of the Jovian magnetosphere. Still, even reduced numbers of images will offer spectacular views of Jupiter and its moons.

Before it reaches Jupiter, however, Galileo will visit the asteroid 243 Ida. The spacecraft will fly past Ida on August 28 this year. Scientists are eager to compare Ida's shape and surface with Gaspra's, the only other asteroid seen close up. Then Galileo will settle down for the cruise out to Jupiter, where it arrives December 7, 1995. ☐



Life on an Older Earth

If intelligent life on Earth took 9 billion years to evolve, this life would see a larger Sun, a smaller Moon, and a more slowly expanding universe.

by Neil F. Comins

Our view of the universe is one flavored by time. The universe evolves, so Earth's surface, eclipses, and the stars in the sky appear the way they do only because we have captured them at this unique time. What would the universe look like if evolutionary processes on Earth had taken twice as long to produce creatures who were aware of their own existence — say 9 billion years instead of 4.5 billion years?

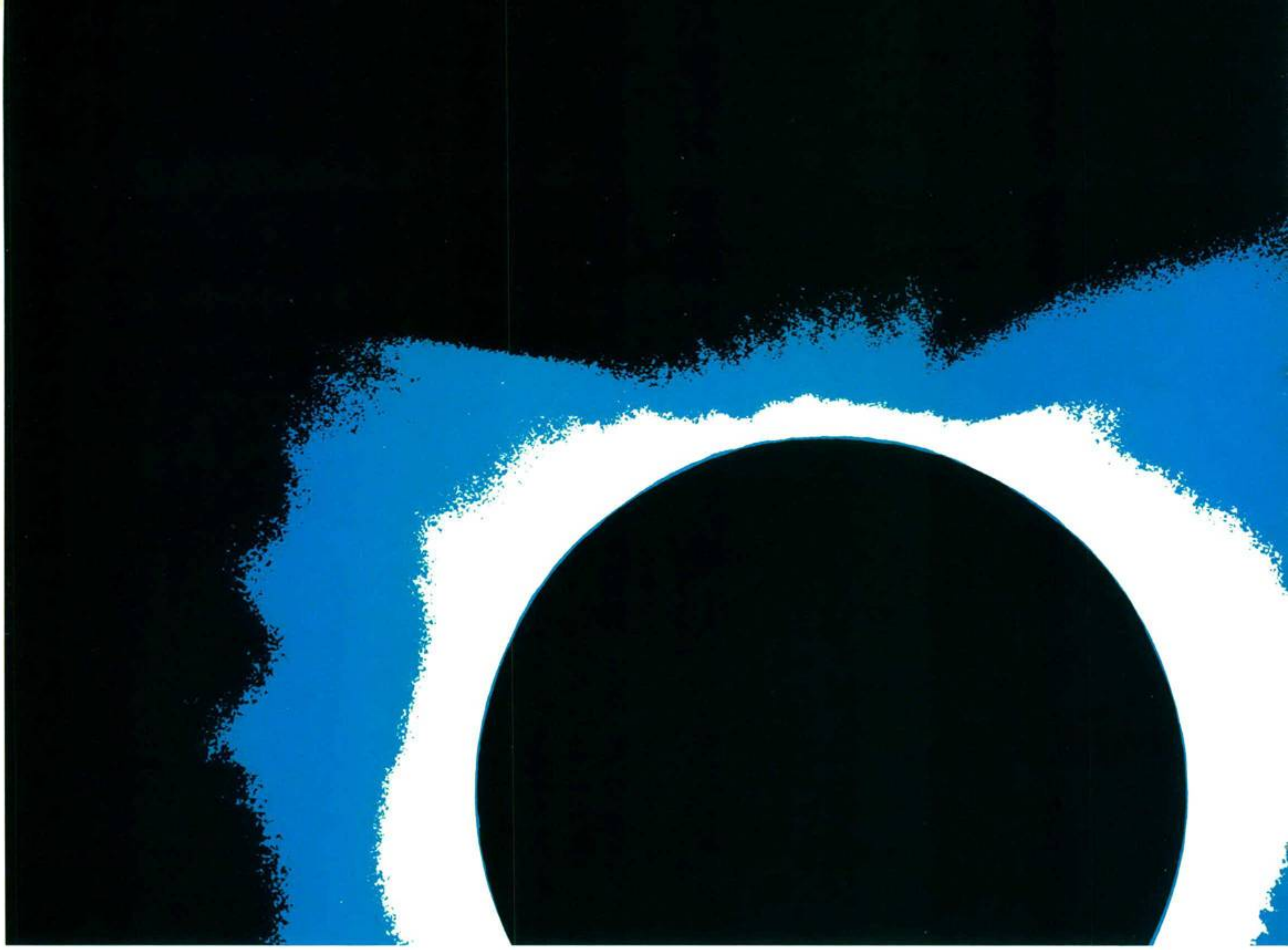
Let's first consider a few of the myriad changes that have occurred in our solar system. Five billion years ago it didn't exist. Billowing clouds of gas and dust thrown into space by exploding stars collided where the Sun and planets would some day reside. There were no clues to the profound changes yet to come.

Then about 4.7 billion years ago the clouds of gas and dust were driven together. The gravity of the resulting cloud forced it to collapse in on itself. In this cloud, the pieces of the solar system began condensing into existence about 4.6 billion years ago. The massive Sun formed in the central, thickest part of the cloud. The remaining debris formed four solid, inner planets (Mercury, Venus, Earth, and Mars) and four massive, gaseous outer planets (Jupiter, Saturn, Uranus, and Neptune), satellites of these planets, and various icy and rocky smaller bodies that we now call comets and asteroids. It is likely that Pluto didn't orbit then where it does now but came to reside there after a collision with another icy dwarf planet. (See "Where Has Pluto's Family Gone?" in the September 1992 issue.)

The coalescence of space debris into planet Earth took less than 50 million years. Then innumerable space rocks and ice chunks bombarded the young Earth for almost 700 million years, increasing its mass and providing water and organic materials. This cosmic organic matter may have started life on Earth. (See "The Cosmic Origins of Life on Earth" in the November 1992 issue.) One collision with a Mars-sized object ejected material from Earth's crust and mantle, producing the Moon.

The original atmosphere was lost to space as collisions expelled some gas while light gases, such as hydrogen, escaped from Earth's gravity. Subsequent volcanic activity released large amounts of carbon dioxide, producing a second atmosphere. This atmosphere was like the one that still exists on Venus and was much denser than Earth's present atmosphere. The young oceans absorbed some of the carbon dioxide while rocks absorbed yet more carbon dioxide to form carbonate rocks like limestone. Atmospheric pressure decreased as a result, but the remaining air still contained primarily

Michael Carroll



carbon dioxide. Around two billion years ago, primitive plants evolved and started to convert the carbon dioxide into oxygen and carbon, returning the oxygen to the air.

By about a billion years ago, our present nitrogen-oxygen atmosphere was in place. Shortly after, single-celled animals called protozoa started evolving into multicellular organisms. Creatures developed specialized organs 600 million years ago and primitive mammals evolved about 200 million years ago, shortly before the reign of the dinosaurs. One of the first human species to walk upright was *Australopithecus afarensis,* the oldest example of which is "Lucy," who lived about 4 million years ago. The early hominids evolved into *Homo erectus* almost two million years ago and the first member of our species, *Homo sapiens,* appeared only 250,000 years ago. Our modern ancestors, *Homo sapiens sapiens,* appeared around 35,000 years ago.

Delaying Evolution

Although evolution of complex brains almost certainly made self-aware creatures like ourselves inevitable, the sequence of events that enabled Earth to support humans at this time in our planet's history was by no means inevitable. For instance, Earth need not have cooled off enough to support a solid surface after only 700 million years. Earth was initially molten; indeed, radioactive elements and the pressure of the planet's matter pushing inward have kept much of the interior molten even to this day. The outer layer, or crust, lost heat into space, eventually cooling into a semi-solid, or plastic, layer. If the fraction of radioactive elements were higher, it could have taken hundreds of millions of years more for the surface to stabilize and solidification to occur.

Also, the conversion of our atmosphere from primarily carbon dioxide to oxygen and nitrogen demanded not only that the carbon dioxide be removed in sufficient quantities but that the compounds that combine with free oxygen be saturated — that they contain as much oxygen as they could chemically bond. This latter point is by no means trivial; oxygen is extremely reactive. Even without combustion, oxygen combines with many compounds such as carbon monoxide in the atmosphere and iron in rocks. Until all such reactants were saturated with oxygen, there was not sufficient free oxygen for animals to breathe. Slight changes in surface or atmospheric chemistry could have delayed a stable oxygen and nitrogen atmosphere by hundreds of millions of years or even longer.

Along the same vein, some astronomers conjecture that the original carbon dioxide atmosphere of Earth may have been many times denser than the secondary atmosphere plants started attacking. After all, the present atmosphere of Venus is 95 times thicker than ours and contains primarily carbon dioxide. If the Moon formed from a collision, the energy in that impact would have had sufficient power to eject into space most of Earth's early atmosphere. Without that loss of

The Moon's present distance enables it occasionally to block out the Sun's disk, creating a total solar eclipse and revealing the Sun's corona.

carbon dioxide, the thick atmosphere would trap heat from the Sun's rays and be hot enough to slow absorption of carbon dioxide by the rocks and oceans. It easily could have taken an extra billion years to change into an oxygen and nitrogen atmosphere. Also, plants living in a thicker carbon dioxide atmosphere may have generated oxygen more slowly. They may consider oxygen to be toxic, as anaerobic bacteria do, so the production of oxygen might have required the evolution of different plant forms to cope with the changing atmosphere.

And collisions by comets or asteroids may have caused more extinctions of living things on Earth. The mass extinction of the dinosaurs and half of everything else alive on the planet 65 million years ago is one example of this. If an extinction had occurred at a critical juncture in evolution, such as when multicellular organisms were first forming or when internal organs began differentiating, then later evolutionary steps could have been delayed by millions of years. Perhaps this did happen, delaying our evolution by a hundred million years.

Finally, if the primate line leading to humans had faltered and no other creature had developed a complex-enough brain, the cycle of evolution may have had to repeat itself, perhaps several times, before self-aware beings appeared. A mass extinction in recent history could have even wiped out advanced life. It is feasible, then, that intelligent beings might not have appeared until billions of years later than we did. Let's imagine that it took 9 billion years instead of only 4.5 billion, until humans evolved.

A Different Earth

Would these later "humans" be like us? The evolutionary process that led to humans is unique and the likelihood is small that the sentient, or self-aware, creatures who evolved here in the future would look like us. But no matter. Recent advances in the theory of neurological development suggest that eventually a species would evolve that would be self-aware and curious about its surroundings. But the New Earth they inhabit would look very different from the one we enjoy today.

The continents and oceans will be different. The crust of Earth is composed of granitic continental plates somewhat like closely packed icebergs, floating not on water but on Earth's basaltic mantle. The mantle is the thick layer of molten rock, or magma, just below the crust. Radioactive decay of elements generates heat in Earth's interior. This heat melts some of the rock in the mantle and causes this magma to rise toward the surface. The rising magma, occurring mostly in the oceans, pushes the plates apart. Where the magma cools, the plates slide over one another, returning material to the mantle. Sometimes this converging material doubles the size of the crust, causing mountains to thrust into the sky, such as in the northwest part of the United States.

The plates have been moving relative to each other through recorded geologic history. Geologists believe that 350 million years ago a massive continent called Gondwana lay in the Southern Hemisphere. This land mass drifted north, connecting with other continents about 260 million years ago to form one super-continent called Pangaea. Then they slowly moved apart from Pangaea's core, which now forms Africa, dispersing into the continents of today.

The continents are still drifting, and 4.5 billion years from now their distribution will be completely different. No pattern of land that we recognize today will remain intact. The Mediterranean Sea will be gone, and the Atlantic may be as wide as the Pacific is today, while the Pacific will probably be much narrower. The islands of the Pacific, from Japan south to Australia, may be a single connected unit. New islands will grow over hot spots in the mantle, just as the Hawaiian Islands do today. The Andes and Himalayas will have tried to rise higher, only to come tumbling down under the force of their own weight. The world map of New Earth would be unrecognizable to today's humans.

Another major change is the length of one day. It will be almost twice as long as our day. Also the Moon will be about 1.5 times farther away, appearing correspondingly smaller in the sky, and take 1.8 times as long to travel through the sky. The longer day and more distant Moon are intimately related through the ocean tides created by the Moon's gravity. As tidal waters rub against the solid Earth, the resulting friction slows Earth's rotation and currently causes the day to grow 0.002 seconds longer each century. The energy lost as Earth spins down must be retained in the Earth-Moon

Observers 4.5 billion years from now will never see a total solar eclipse, because the more distant Moon will cover only 40 percent of the Sun's diameter.

system, so the Moon must speed up in its orbit around Earth. This increase in speed presently forces the Moon to move farther away from Earth at a rate of 4 centimeters per year.

Since the Moon appears smaller in the sky, future humans will never see a total eclipse of the Sun. The best they will see is an annular eclipse, with a broad ring of the Sun showing around the edges of the Moon. Total lunar eclipses will still occur because Earth's shadow will remain larger than the size of the Moon.

Changes in the Night Sky

Presently Polaris appears almost exactly over Earth's north rotation pole. But in all likelihood, humans of the future won't see a pole star for two reasons. First, Earth's rotation axis precesses, or wobbles, by 23.5 degrees over a period of about 25,800 years, making the pole wander around the sky. We are fortunate that in recent centuries there has been a bright star to mark the north pole. Second, many bright stars that come to lie near the pole may no longer be visible, having used up their nuclear fuels in the next 4.5 billion years. Polaris itself will explode as it nears the end of its life cycle, as nuclear reactions run away deep in its interior. Perhaps new bright stars will form that will take turns as future polar guide stars as Earth's rotation axis precesses, much as Polaris and Thuban in Draco have in the past.

Many of the stars that we see now will no longer exist, having exploded as either supernovae or planetary nebulae. These include most of the brightest stars — Sirius in Canis Major, Vega in Lyra, Capella in Auriga, Rigel and Betelgeuse in Orion, Antares in Scorpius, Regulus in Leo, and Deneb in Cygnus, to name a few. Asterisms (patterns of stars) such as the Big Dipper or Orion, will all be different too, since even the stars that still exist in 4.5 billion years will have moved relative to each other.

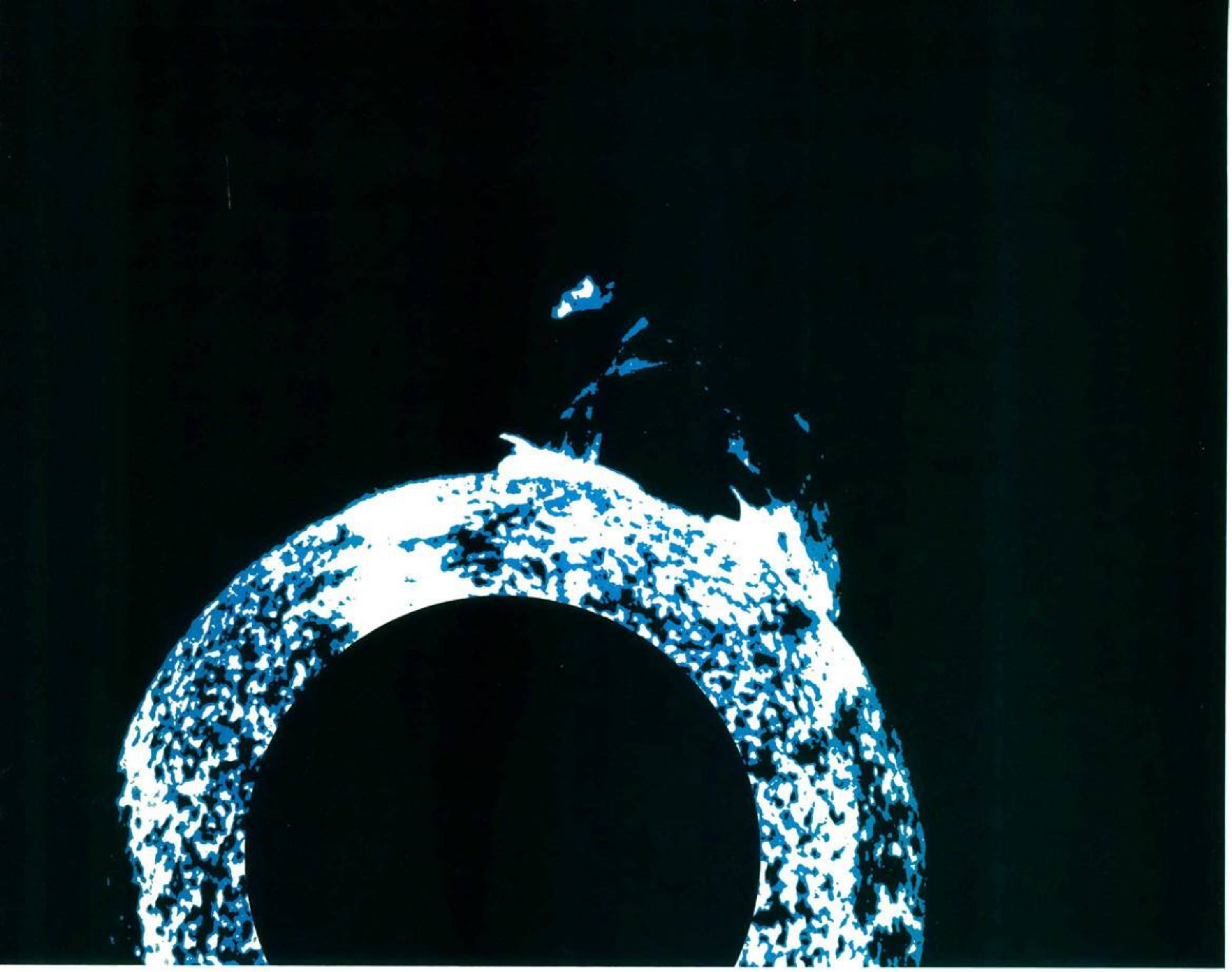
The future counterpart of astronomer Edwin Hubble will, like Hubble, discover that distant galaxies appear to move away from us due to the expansion of the universe. Hubble made systematic errors in determining the distances to some of the distant galaxies, which affected his calculation of how fast galaxies move apart. Even today, 65 years later, the speed is known only to a factor of two, but it is almost certainly between 15 and 30 kilometers per second per million light-years. That means that a galaxy one million light-years distant moves away from our Milky Way Galaxy with a speed between 15 and 30 km/sec. A galaxy twice as far away moves twice as fast, and so on. Astronomers call this rate of expansion of the universe the Hubble constant. Many astronomers believe that the Hubble constant is about 23 km/sec per million light-years. However, the Hubble constant is not at all constant. When future astronomers measure the speed of distant galaxies moving away from us, they will get a very different number because the expansion of the universe is slowing down.

On Earth, when you jump gravity pulls you back. Similarly, the gravity of one galaxy pulls back the galaxies moving away from it. The gravitational pull of all the galaxies in the universe slows the expansion.

Whether gravity is strong enough to cause the universe to collapse someday depends on how much matter there is in the universe. So far, astronomers have seen only about 5 to 10 percent of the matter necessary to completely stop the expansion; they believe that most of the mass in the universe exists in an unseen form they call dark matter. Despite efforts to measure how much matter there is in the universe, no one yet knows for sure whether the universe will continue to expand forever. But even if the universe is going to collapse upon itself someday, it won't happen within the next 4.5 billion years. Instead, the future Edwin Hubble will likely find an expansion rate about one-half or one-third the present value. The universe will be much larger than it is today, but it will definitely move apart more slowly.

A Brighter Sun

The Sun will still have nearly the same surface temperature and yellowish hue that is has now but will appear about twice as bright because it will be about 60 percent bigger. The extra 4.5 billion years will have begun to take their toll on the Sun's nuclear fuel supply. The Sun is a gaseous ball composed of two thousand trillion trillion tons (or 2×10^{30} kilograms) of matter. This gas contains primarily hydrogen and helium, with traces of other elements. For every million atoms of hydrogen



there are about 85,000 helium atoms and only about 1,000 of any other kind of atom. Pressure from all that mass crushing down on the center of the Sun is high enough that hydrogen atoms fuse together — or "burn" — in the core to form helium. This simultaneously creates new energy, which keeps the Sun from collapsing further and provides the energy that allows it to shine.

The Sun has fused hydrogen into helium throughout its present lifetime of 4.5 billion years, using up less than half of the available hydrogen in its core. In another 4.5 billion years, 80 or 90 percent of the available hydrogen in the core will have been converted into helium. Serious questions about the fusion rate in the Sun still remain, but the humans of the future will face a Sun that is running out of core hydrogen.

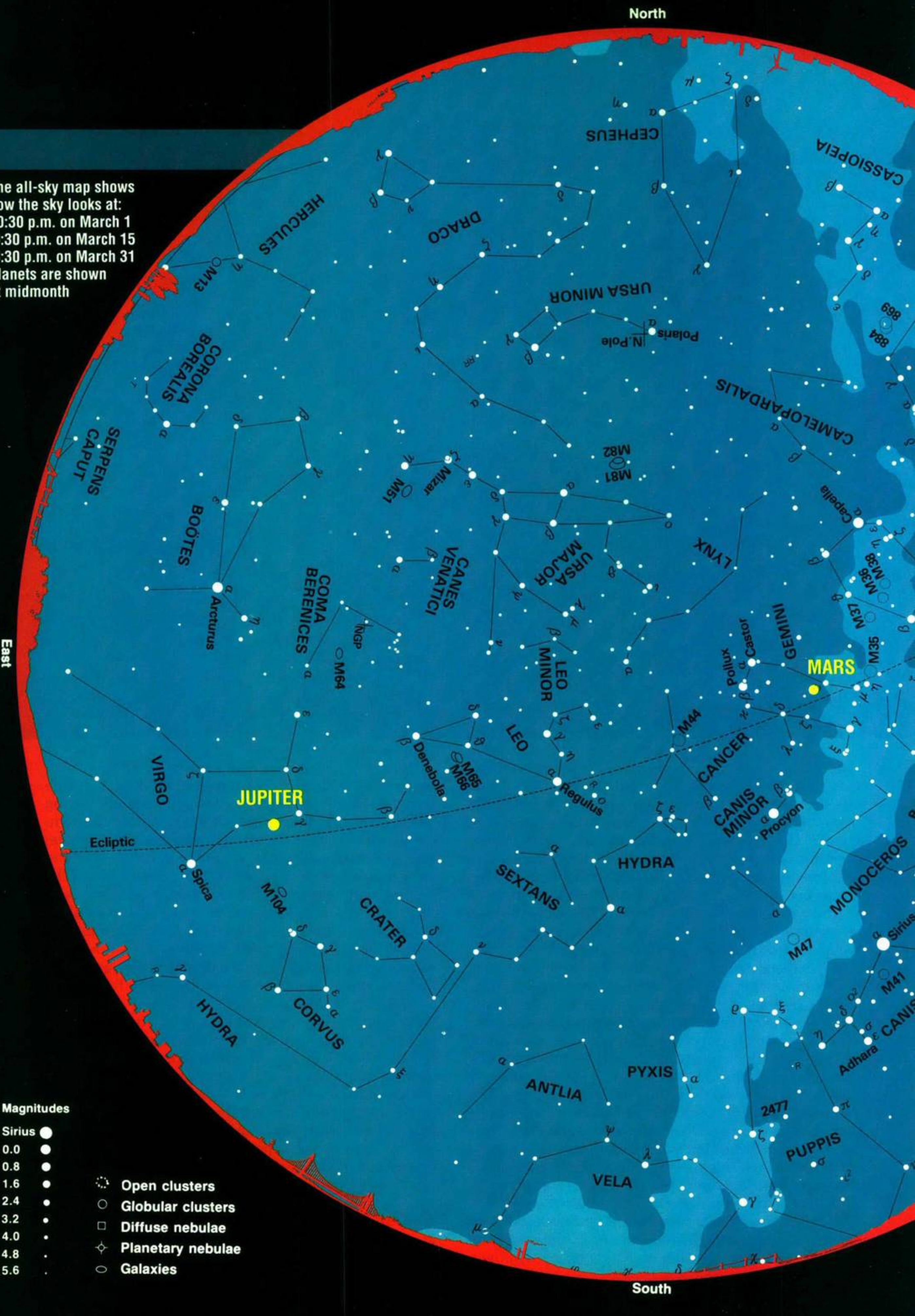
When this fuel runs out, the gas temperature and pressure will drop and the interior of the Sun will collapse under the weight of the surrounding mass. The pressure in the collapsing gas will build up sufficiently for a shell of hydrogen to start burning around the core, now helium. This fusion will provide an outward force on the outermost layers of the Sun, pushing them farther out than they are now. The surface of the Sun will expand outward until it reaches the orbit of Venus.

Eventually this hydrogen outside the core will run out. The core of the Sun will continue to contract, trying to replace the heat no longer generated by hydrogen burning. When the internal temperatures reach 100 million kelvins, the helium generated by hydrogen burning will itself start to burn. This will happen quickly, forming a carbon-rich core. Around this burned-out core, helium burning will start. Around the helium-burning layer, a shell of hydrogen also will start to burn. The vast energy released by both of these shells will push the Sun's outer layers out until they reach the orbit of Jupiter. Earth will be inside the Sun. The temperature on the surface of Earth around 6.5 billion years from now will be around 30,000 kelvins, and everything organic will be burned to a crisp. (See "The Fiery Fate of the Solar System" in the April 1990 issue.)

Intgelligent life 5 or 6 billion years from now will face the pressure to leave Earth and, indeed, our solar system. They will need to colonize planets around younger and therefore more stable stars in order to live. It is likely that humans in the near future will move off Earth in search of mineralogical and economic gain, whereas the future beings of our speculation will move off to save its species. The aging Sun will give future life a focus and a goal — survival. ☐

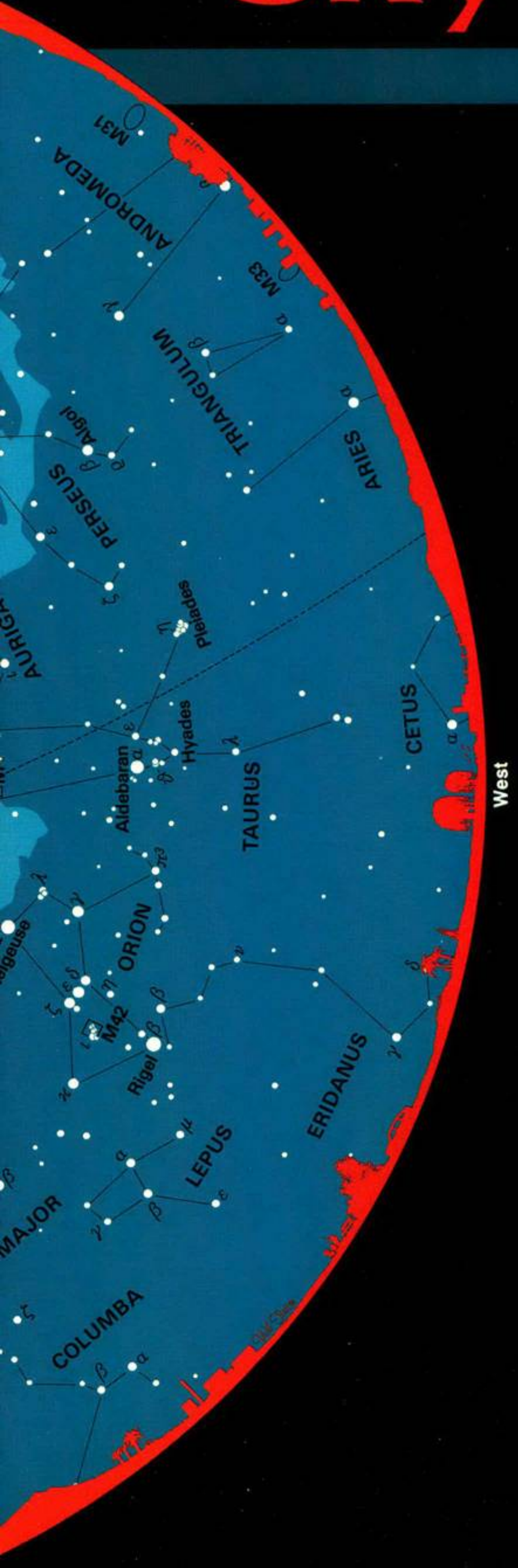
Neil F. Comins is a professor of physics at the University of Maine. This is the last of his "What If?" articles, which started in the February 1991 Astronomy.

The all-sky map shows how the sky looks at:
10:30 p.m. on March 1
9:30 p.m. on March 15
8:30 p.m. on March 31
Planets are shown at midmonth


North
East
South
HERCULES
M13
DRACO
CEPHEUS
CASSIOPEIA
URSA MINOR
Polaris
N. Pole
869
884
CAMELOPARDALIS
CORONA BOREALIS
SERPENS CAPUT
BOÖTES
Arcturus
M51
Mizar
M82
M81
Capella
CANES VENATICI
URSA MAJOR
LYNX
COMA BERENICES
NGP
M64
LEO MINOR
GEMINI
Castor
Pollux
M36
M38
M37
M35
MARS
M44
CANCER
LEO
Denebola
M65
M66
Regulus
VIRGO
JUPITER
Ecliptic
Spica
CANIS MINOR
Procyon
HYDRA
SEXTANS
MONOCEROS
M104
CRATER
M47
Sirius
M41
CANIS
CORVUS
HYDRA
Adhara
PYXIS
ANTLIA
2477
PUPPIS
VELA
Magnitudes
Sirius ●
0.0 ●
0.8 ●
1.6 ●
2.4 •
3.2 •
4.0 •
4.8 ·
5.6 ·
Open clusters
○ Globular clusters
□ Diffuse nebulae
Planetary nebulae
⬭ Galaxies

Sky Almanac

March 1993



Map Art by Wil Tirion

JUPITER REACHES OPPOSITION

The king of the planets is at its best for the year during March. Jupiter reaches opposition on March 30, when it rises at sunset and is prominent all night long, glowing at magnitude –2.5. Telescopes show its intricate belts, zones, and Great Red Spot.

LAST LOOK AT BRILLIANT VENUS

Approaching Earth and slipping out of the evening sky, Venus is the brightest "star" low in the west after sunset. The planet is brightly visible early this month but by month's end slips too close to the Sun to be seen.

MARS CROWNS THE NIGHT SKY

The Red Planet is an evening object this month, easily visible as the ruddy, bright "star" in Gemini. Mars is high in the sky at dusk and sets after midnight. In a telescope the planet's disk measures 8.9", large enough to see dark markings on the Martian surface.

COMET SCHAUMASSE ADORNS EVENING SKY

Periodic Comet Schaumasse offers observers a chance to see an 8th-magnitude comet as it traverses the constellations Auriga and Lynx this month. The comet will appear in binoculars and scopes as a small, nebulous patch of light perhaps sporting a short tail.

Calendar of Events

1 First Quarter Moon is at 10:46 a.m. EST
Pluto is stationary
8 The Moon is at perigee (221,535 miles from Earth), 4 a.m. EST
Full Moon is at 4:46 a.m. EST
Mercury is in inferior conjunction
9 The Moon passes 6° south of Jupiter, 11 p.m. EST
Venus is stationary
14 Last Quarter Moon is at 11:16 p.m. EST
17 The Moon passes 2° north of Neptune, 2 a.m. EST
The Moon passes 3° north of Uranus, 4 a.m. EST
20 The Moon passes 6° north of Saturn, 3 a.m. EST
Vernal equinox is at 9:41 a.m. EST
21 The Moon passes 4° north of Mercury, 8 a.m. EST
The Moon is at apogee (252,667 miles from Earth), 2 p.m. EST
Mercury is stationary
23 New Moon is at 2:14 a.m. EST
24 The Moon passes 4° south of Venus, 3 a.m. EST
30 Jupiter is at opposition, 7 a.m. EST
First Quarter Moon is at 11:10 p.m. EST
31 The Moon passes 5° south of Mars, 2 p.m. EST

Eye on the Sky

by Deborah Byrd

JUPITER OPPOSITE THE SUN

Walk outside early this month a little after nightfall, look toward the east, and you'll find Jupiter ascending. It's a glorious beacon at magnitude –2.4, and it brightens by a tenth of a magnitude by the end of the month. Compare Jupiter with Venus, which is in the west after sunset early in the month. Venus is brighter, as always, but it shines in the midst of evening twilight. Jupiter is somewhat fainter, but it can be seen against a background of inky darkness. No wonder Jupiter is called the king of planets.

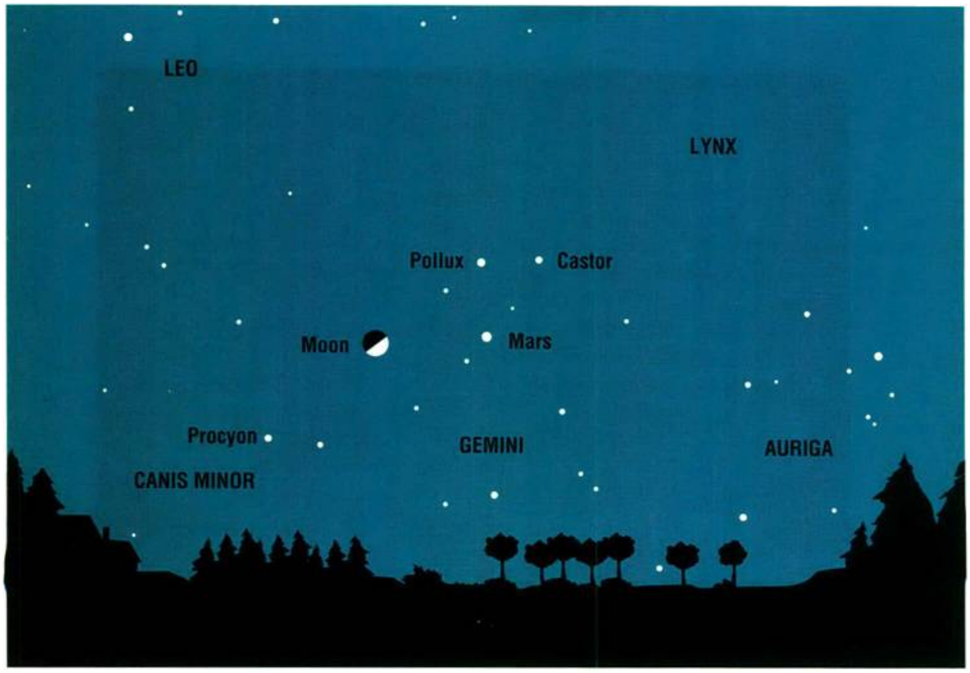
Jupiter comes to opposition on March 30. On that day Earth passes between this planet and the Sun, placing Jupiter opposite the Sun in our sky. Then Jupiter rises at sunset and wheels across the sky until dawn. But don't wait until the day of opposition to enjoy observing the planet. It's in the sky nearly all night during March and April.

Jupiter is now generally closest to Earth and brightest for the year. It is the largest planet in our solar system; over a thousand Earths could fit inside it. It orbits at more than five times Earth's distance from the Sun, but it's so gigantic that it always appears bright. Because we are closest to Jupiter currently, the planet appears at its brightest. Sunlight reflecting from Jupiter's clouds travels to Earth in only 37 minutes now. That's in contrast to its distance this coming October, when Jupiter will be traveling behind the Sun from Earth. Then the reflected sunlight will take nearly 54 minutes to reach us.

Jupiter travels around our sky once every 12 years because it takes that long to complete a single orbit around the Sun. We travel around the Sun once a year. Because Jupiter moves through one-twelfth of its own orbit during each earthly year, Jupiter's oppositions always come about a month later each year. There are 12 zodiacal constellations — so Jupiter's oppositions nearly always occur in the constellation of the zodiac next door to the one of a year ago. Jupiter came to opposition last year in front of the constellation Leo. This year, the planet shines like a beacon in front of star-poor Virgo.

Be sure to turn your binoculars on Jupiter now that the planet is so conveniently placed for evening viewing. One or more of Jupiter's four largest moons — called Io, Europa, Ganymede, and Callisto — will pop into view. Some people have spotted Jupiter's largest moon, Ganymede, with the naked eye around the time of Jupiter's opposition. If you want to see Ganymede with the naked eye, you will need a moonless night and a dark, country observing site. It will appear as a starry point nearly drowned in Jupiter's glare.

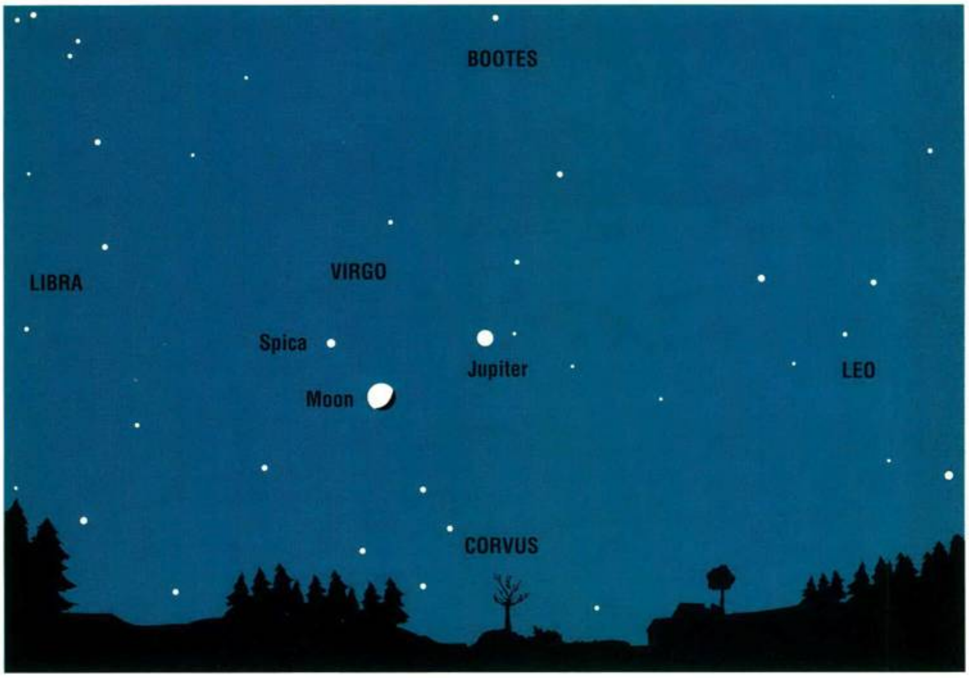
THE MOON PASSES MARS on the evening of March 31, when the two objects — visible in the western sky in the constellation Gemini — are separated by a mere 5°.



SPRING BEGINS IN THE NORTHERN HEMISPHERE

The vernal equinox this year comes on March 20. On that day, the Sun crosses the celestial equator moving from south to north. The celestial equator is just an imaginary line on the sky above Earth's equator. Unless you happen to be at one of Earth's poles — in which case you can't see the celestial equator — this imaginary line across the sky intersects your horizon at points due east and due west. Because the Sun crosses the celestial equator on the day of the equinox, the Sun rises due east and sets due west on this day.

That's true not just for us in the Northern Hemisphere. All of us on Earth see the Sun rise due east and set due west on the day of the equinox. So this and every equinox is really a global experience. Unless you live very near one of Earth's poles, your day and night are just about equal length around the day of the equinox. (The word *equinox* means "equal night.") The vernal equinox marks the first day of autumn for people south of the equator, the first day of spring for people north of it.



JUPITER AND THE MOON gang up on March 10, when the two make a stunning pair in the southwest in the morning sky.

MARCH'S PLANETS

The brightest planet, **Venus**, can be found in the west in early evening. As the month passes it sinks closer to the western horizon each evening and then disappears. Two factors work together to keep Venus visible longer than you might expect. The ecliptic — or path of the Sun, Moon, and planets — makes a steep angle with the horizon in the evening at this time of year. Also, Venus is very brilliant, shining at magnitude –4.5. You should be able to follow Venus deep into the twilight glare. Binoculars will also come in handy when you can no longer see it with the naked eye. Can you spot Venus on the evenings of March 23 and 24, when it is near the young Moon? Venus will pass between the Sun and Earth on April 1.

Another planet can be found in the early evening sky. **Mars** appears high in the southeast after the Sun goes down. The Red Planet shines at magnitude –0.1 when the month begins, but it dims rapidly as we fly ahead of it in our smaller orbit around the Sun. By early April, Mars will shine at magnitude 0.6. This planet is near the Moon twice this month, on March 3 and March 31. Mars is still in the constellation Gemini, and it spends the month moving eastward toward Gemini's brightest stars, Castor and Pollux.

The giant planet **Jupiter** comes up in the east at the end of evening twilight in early March. You can't miss it. Once Venus has set, no star or planet outshines it. Jupiter rises progressively earlier throughout the month and finally comes up within minutes of sunset on March 30. On that day, the planet is opposite the Sun. It dominates the sky all night from its location in the constellation Virgo. Watch for Jupiter near the Moon on the night of March 9/10. The Moon is just past full that night. Next month, Jupiter will appear even closer to the Full Moon as we look opposite the Sun to see them both.

On spring mornings, the ecliptic makes a narrow angle with the horizon. **Saturn** comes up shortly before the Sun in early March, but the shallow angle of the ecliptic to the horizon makes the planet hard to see. If you have keen eyes and an exceptionally transparent sky, you might be able to spot Saturn. It shines at magnitude 0.8 when the month begins. Saturn has been in Capricornus for some time. This month, it moves into Aquarius. It'll be easier to see — a steady golden light rising shortly before sunup — next month. Try to spot Saturn near the waning crescent Moon on the morning of March 20.

Mercury is in inferior conjunction — between the Sun and Earth — on March 9. Afterward, it returns to the sky before dawn, but it never gets very far above the horizon before dawn. It's even harder to see than Saturn. Your best chance to see it may be on March 21, when Mercury is near the waning crescent Moon. You'll definitely want to use binoculars! Mercury will be at greatest elongation, its greatest apparent distance from the Sun in the sky, in early April. Unfortunately, this will be an extremely unfavorable apparition for Nothern Hemisphere observers because the planet is so low in the sky.

THE STARRY SKY

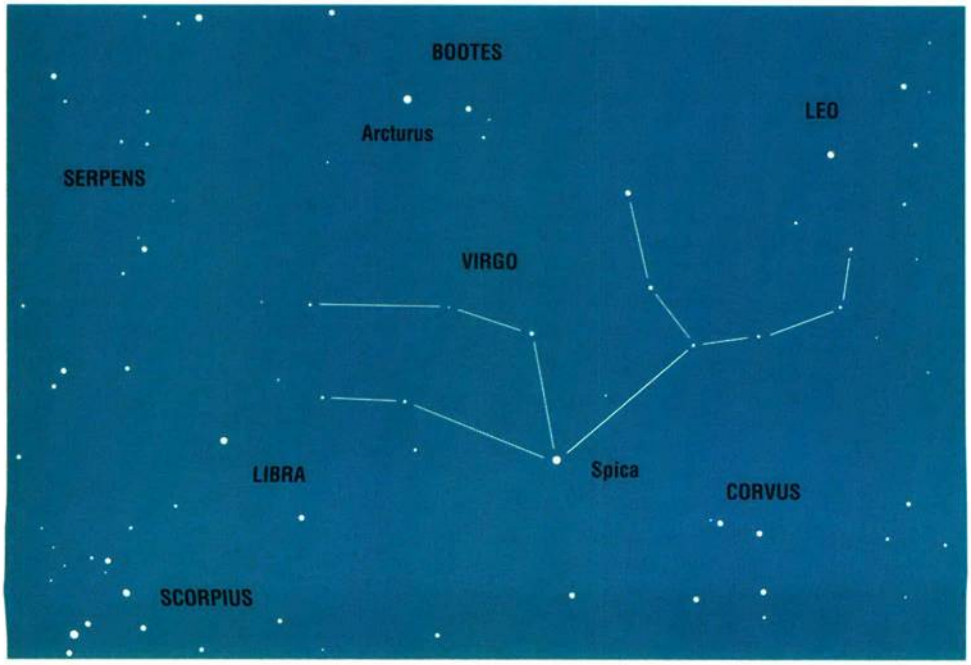
The planet Jupiter appears very brilliant at this year's opposition because it is in a star-poor region of the sky. It stands in front of the constellation Virgo the Maiden. This constellation has only one bright star, Spica, which is about 12° below Jupiter when the planet ascends in the east each evening.

Virgo is one of twelve constellations of the zodiac. In many Northern Hemisphere cultures, its appearance after sunset has been tied to fertility and the coming of spring. In his book on the myths and legends of the sky, *Beyond the Blue Horizon*, E. C. Krupp offers the following information. He points to the newly plowed fields of springtime. Before they are seeded, the furrows are "virgin." After they are seeded, they bear new life. The Sumerian name for the star Spica is Ab-sin, which means furrow.

Virgo happens to be located near the North Galactic Pole, the point on our sky directly above our Galaxy's north pole. It is well out of the disk of the Milky Way Galaxy. If you own a small telescope, be sure to sweep in this vicinity of the heavens. Many tiny blips and blurs of light will come into view. These are really separate galaxies, each containing some millions or billions of stars.

With the naked eye, you'll notice a prominent star near Jupiter. This is 3rd-magnitude Porrima, also known as Gamma Virginis, revealed by telescopes to be a fine double star whose two components are nearly identical in appearance. This star's duplicity was discovered in 1718. They orbit their common center of gravity once every 171 years. At closest approach, the two appear as a single star from our vantage point. They looked single through telescopes in 1836 and will do so again in about the year 2007. People love these stars! And you can see them with a telescope on any clear night this spring. □

NESTLED BETWEEN LEO AND SCORPIUS, Virgo the Maiden hosts the bright blue-white star Spica and is currently the constellation against which we see Jupiter.



Deborah Byrd writes and produces the daily "Earth and Sky" radio series now heard on over 140 radio stations. Her most recent articles for Astronomy *were "Exploring the Spring Sky" (this issue) and "Exploring the Winter Sky," (December 1992).*

Through the Eyepiece

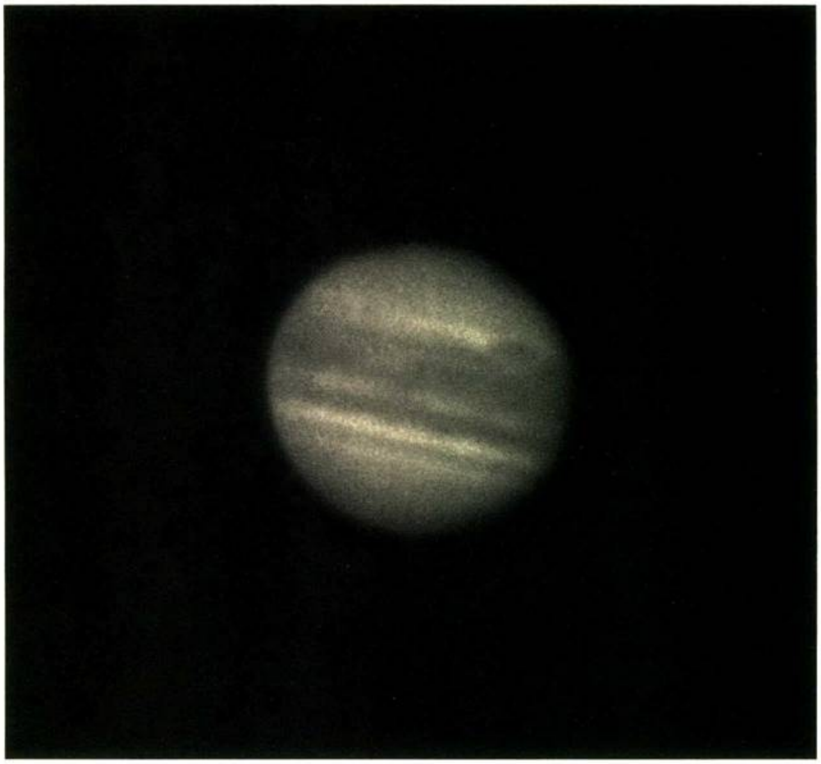
by Jeff Kanipe

JUPITER AT OPPOSITION

Jupiter's opposition on March 30 is the key event this month for observers equipped with telescopes. Jupiter is such a large, detail-rich object that it looks great most any time, but especially at and around opposition. An opposition marks the instant when an outer planet is opposite the Sun in our sky. Although there's no significant reason to look at an outer planet at the very moment of its opposition, you certainly should observe it in the days around opposition when it is nearest Earth, displays its largest angular diameter, and is visible all night. Consider it a kind of poor-man's flyby. In this case, Jupiter and Earth are separated on the night of opposition by about 414 million miles.

At opposition this year, Jupiter shines with a magnitude of –2.5 and swells to an angular diameter of 44.2", which is about 5" less than that of the October 1987 opposition. Magnifications in the 45x range will yield a disk size a bit larger in apparent diameter than a naked-eye view of the Full Moon. This is enough to reveal subtle cloud features if your telescope is properly collimated and the seeing is steady. It also helps if you observe with a patient eye.

Jupiter's upper cloud deck is marked by alternating bands of dark and light clouds (belts and zones, respectively), swirling eddies, and wondrous storm systems. It's a meteorologist's dream world or worst nightmare (who would want to try to predict the weather on Jupiter?). The planet's atmosphere is driven largely by its 9.8-hour rotation period and heat rising from its warm interior and mixing with the howling upper air streams. The forces that sculpt the features we see arise in a mantle of liquid molecular hydrogen, which itself envelops a thick layer of metallic hydrogen.


Gregory Terrence

BELTS AND ZONES on Jupiter will be easily visible throughout the month as the giant planet reaches opposition.

The equatorial zone harbors many of the planet's more interesting features. Here you find the delicate blue "festoons" arcing into the equatorial zone from the southern edge of the North Equatorial Belt (NEB). These festoons look like gray or bluish commas. These dark protuberances are thought to be a discrete system of deep holes in Jupiter's cloud deck. Infrared data show these features to be thermal sources that are much warmer than their surroundings. They look blue because they may be filled with water droplets and "snow." A Wratten #25 red filter gives these features a bit more contrast in the eyepiece, though I have never had a problem seeing them in my 8-inch Newtonian at 125x.

Other features to look for in Jupiter's normally quiet northern hemisphere are dark or white spots moving rapidly along the southern edge of the North Temperate Belt (the narrow, dark belt just north of the NEB). Although they typically coincide with Jupiter's perihelion, don't rule out the possibility that an outbreak of these features might occur now, because their appearance is largely unpredictable. To see them best, use a Wratten #80A (light blue) or #11 (yellow-green) filter.

The less-prominent South Equatorial Belt (SEB) is home to the planet's most famous feature, the Great Red Spot. Having seen this feature in the early 1960s and 1970s, when it was a distinct burnt-orange hue, I now refer to it as the Not-so-great Red Spot, for it is a gray ghost of its former self. Look carefully for a "cutout" along the southern edge of the SEB, where the Red Spot hollow intrudes. Try a Wratten #58 green filter to help delineate the spot's outline. Despite its faded glory the Spot is a fascinating feature to monitor, for it occasionally moves erratically in longitude, sometimes drifting ahead of or falling behind the other features.

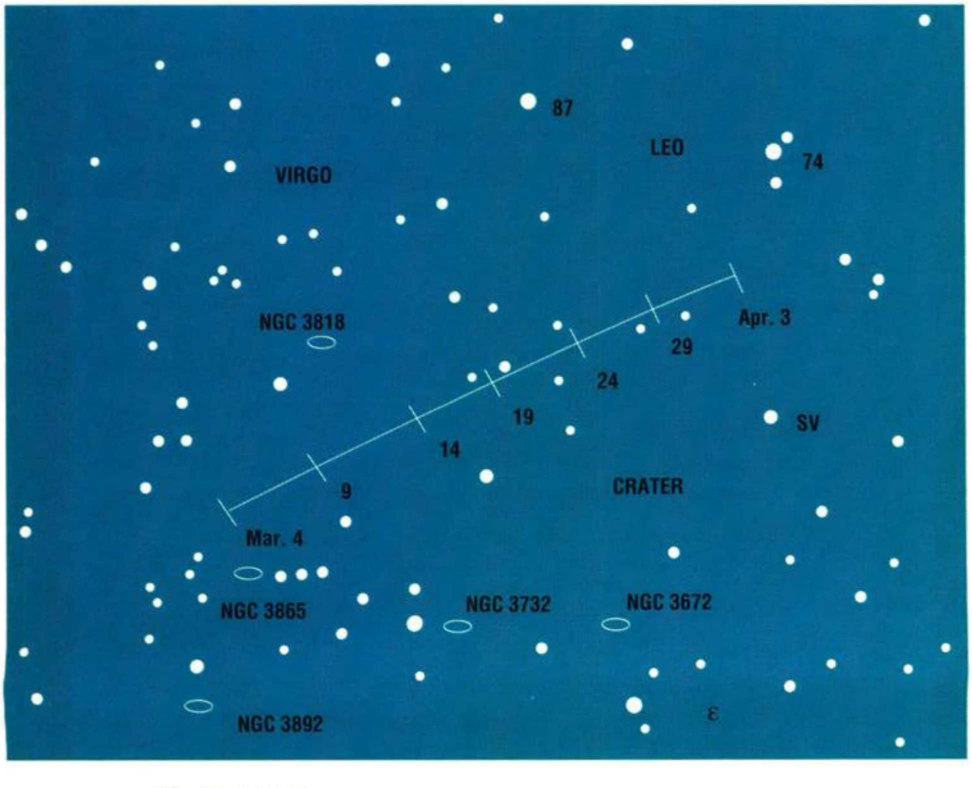
Look for disturbances in the planet's southern hemisphere. These are typically limited to the South Tropical Zone and the South Equatorial Belt. They often begin as discrete dark or bright spots embedded in a zone or belt, but soon develop into streaks. Over the course of a few days, they can lengthen until they extend in longitude nearly halfway around the planet. Some disturbances are even classified as "long-lived," and have been observed off and on for years.

Jupiter is a cornucopia of atmospheric features, many of them unpredictable, but all of them fascinating. Considering the recent disappearance and reappearance of the South Equatorial Belt, the Red Spot's comings and goings, and the turbulent detail in the North Equatorial Belt, the planet bears watching as it nears opposition.

COORDINATES FOR IRIS

Date	R.A. (2000)	Dec.
March 4	11h47.0m	–8°01'
March 9	11h42.4m	–7°35'
March 14	11h37.6m	–7°05'
March 19	11h32.9m	–6°32'
March 24	11h28.3m	–5°59'
March 29	11h24.0m	–5°24'
April 3	11h20.1m	–4°50'
April 8	11h16.7m	–4°18'
April 13	11h13.8m	–3°47'
April 18	11h11.6m	–3°19'
April 23	11h09.9m	–2°54'
April 28	11h08.9m	–2°33'

ASTEROID 7 IRIS comes to opposition on March 17, when it will appear like a 9th-magnitude "star." This month the minor planet moves from Crater into Leo.



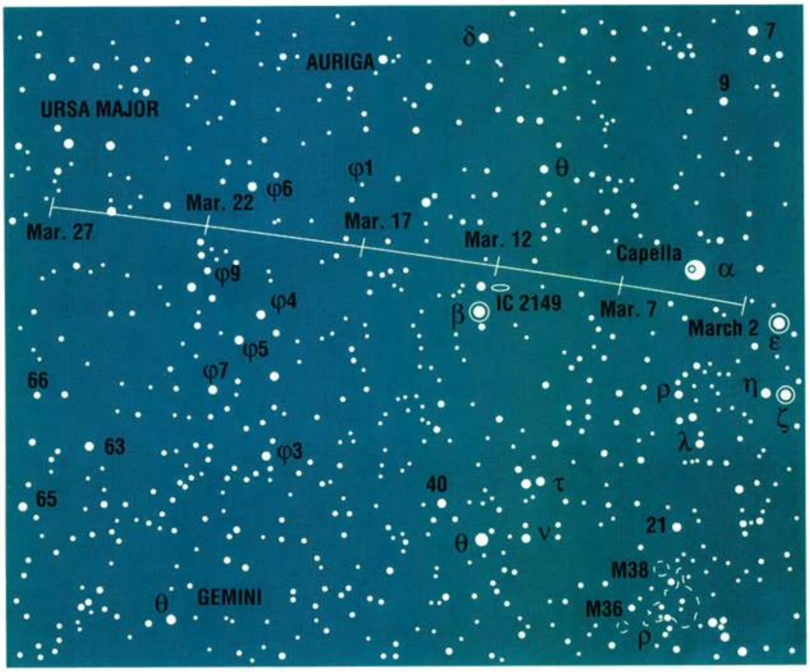
VENUS SLIMS DOWN AND SWELLS OUT

Venus is slipping fast toward the Sun. By month's end, the planet is nearing inferior conjunction and you won't see it shining through the evening twilight. Venus reappears in the morning sky in mid-April. Early in March, Venus lies low in the west and shines at magnitude –4.6. By March 31, the planet dims to –4.1 but grows in apparent diameter to 59" as it approaches Earth.

The weeks prior to and just after inferior conjunction are the best period for observing Venus. As Venus nears the Sun, we see it more backlit, and the phase wanes from quarter to crescent to a very slim crescent. Just before inferior conjunction (which occurs this year on April 1), it may be possible to trace Venus' cusps as they reach into its darkened hemisphere. This effect is caused by sunlight scattering through the planet's upper atmosphere. These cusps may even form a ring around Venus — a very striking effect in any size telescope.

Another feature to look for is the enigmatic and controversial ashen light, a faint glow seen on Venus' night side. Once attributable to electrical or upper atmospheric phenomena (lightning and aurorae), most astronomers today suspect it is not intrinsic to Venus and may be either a contrast effect caused by seeing a bright crescent adjacent to a dark sky or diffraction effects caused by a reflector's secondary mirror supports (although this doesn't explain the ashen-light observations by those using refractors). Whatever its cause, the ashen light is one of those perennial Venus phenomena observers look for around inferior conjunction.

A good pair of steadily held 7x50 binoculars will show the planet does not appear spherical, and a 2- or 3-inch telescope will easily reveal the phase. Because Venus is so bright, magnification is limited only by seeing conditions, which are rarely ideal considering how low in the sky the planet is around conjunction. You might try observing it in the twilight just after sunset, or even before sunset, when the contrast difference between the planet and the bright sky is not as dramatic as it is when Venus is seen against a darker sky background.



PERIODIC COMET SCHAUMASSE is a binocular object this month, glowing at 8th magnitude and sporting a short tail.

A FEW GOOD ASTEROIDS

If 4179 Toutatis got your blood up for asteroids this past December, enjoy the two in the Ophiuchus-Libra-Virgo region that get pretty bright this month. Brightest of these is 7 Iris, which comes to opposition March 14 at magnitude 9.1. With a diameter of 130 miles, this is the largest of the three minor planets visible this month. In mid-February, Iris started its retrograde loop and is now tracking steadily west. On the 14th, it is located about 13½° southeast of Spica and at about the same declination as Beta Scorpii. Those of you with polar-aligned equatorial mounts might prefer to center the field of view on Beta, which lies just a smidgen north of –20° declination, and slew westward 27°; that should put you in the ball park. Over the rest of the month, Iris moves steadily northwestward through the dim stars of southern Virgo, angling toward but never reaching Spica.

Later in the month, on March 24, the asteroid 22 Kalliope reaches opposition. It, too, can be found in Virgo. This 110-mile-diameter body cuts a path just northwest of the 5th-magnitude stars Psi and Upsilon Virginis in late March. On the 24th, it is a bit more than 1° east-northeast of 4th-magnitude Tau Virginis and is slightly brighter than magnitude 11. By the 31st, it lies less than a degree northeast of Tau.

COMET SCHAUMASSE

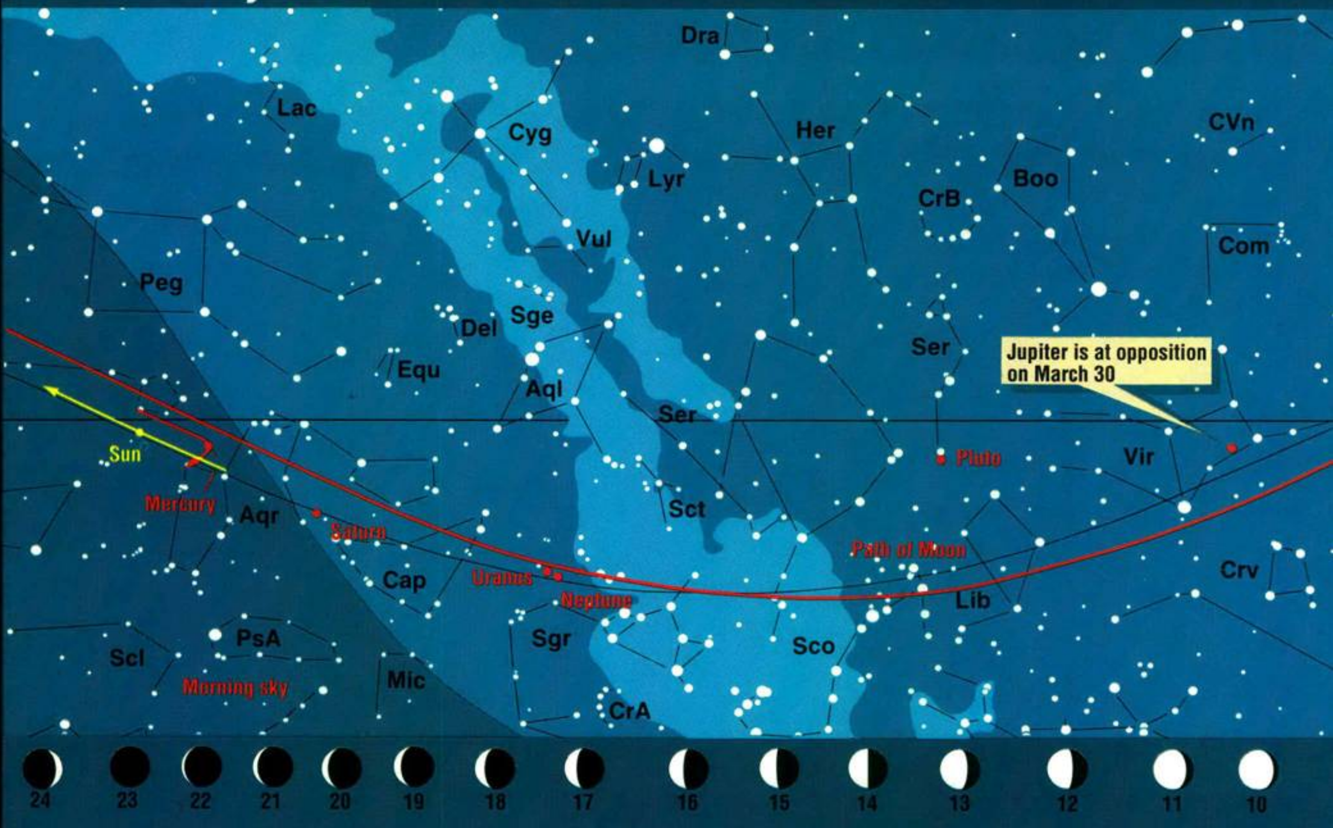
Periodic Comet Schaumasse will be visible this month moving across the constellations Auriga and Lynx in an arc high in the northern sky. The comet will glow at about magnitude 8 and may show a short tail stretching a degree or two. Although it is not tremendously bright as comets go, Schaumasse offers a good view to binocular users or those equipped with small telescopes. Use low power to find the object and observe the shape of its coma and then switch to higher power to see if any details are visible in the inner coma. □

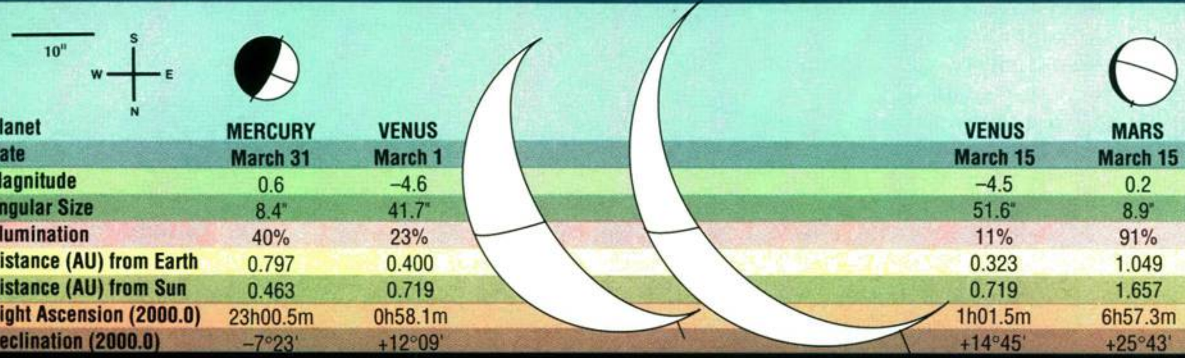
Jeff Kanipe is editor of Star Date, *a magazine published by the University of Texas-McDonald Observatory.*

COORDINATES FOR COMET SCHAUMASSE

Date		R.A. (2000) Dec.
March	2	5h08.4m +44°25'
March	7	5h32.1m +45°47'
March	12	5h58.3m +46°47'
March	17	6h26.6m +47°21'
March	22	6h56.2m +47°25'
March	27	7h26.4m +46°56'
April	1	7h56.1m +45°55'
April	6	8h24.8m +44°25'
April	11	8h51.7m +42°31'
April	16	9h16.6m +40°16'
April	21	9h39.3m +37°46'
April	26	10h00.1m +35°08'
May	1	10h19.1m +32°24'

The Solar System March 1993

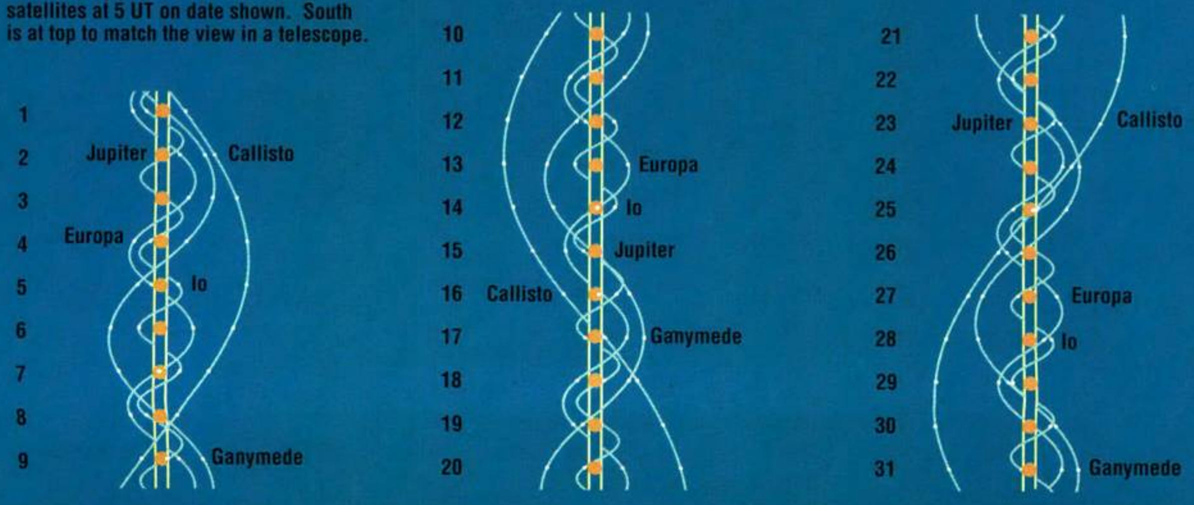

Dra
Lac
Cyg
Lyr
Her
CVn
Boo
CrB
Com
Vul
Peg
Del
Sge
Ser
Equ
Aql
Ser
Jupiter is at opposition on March 30
Sun
Mercury
Pluto
Vir
Aqr
Saturn
Sct
Path of Moon
Cap
Uranus
Neptune
Crv
Lib
PsA
Sgr
Sco
Scl
Morning sky
Mic
CrA
24
23
22
21
20
19
18
17
16
15
14
13
12
11
10

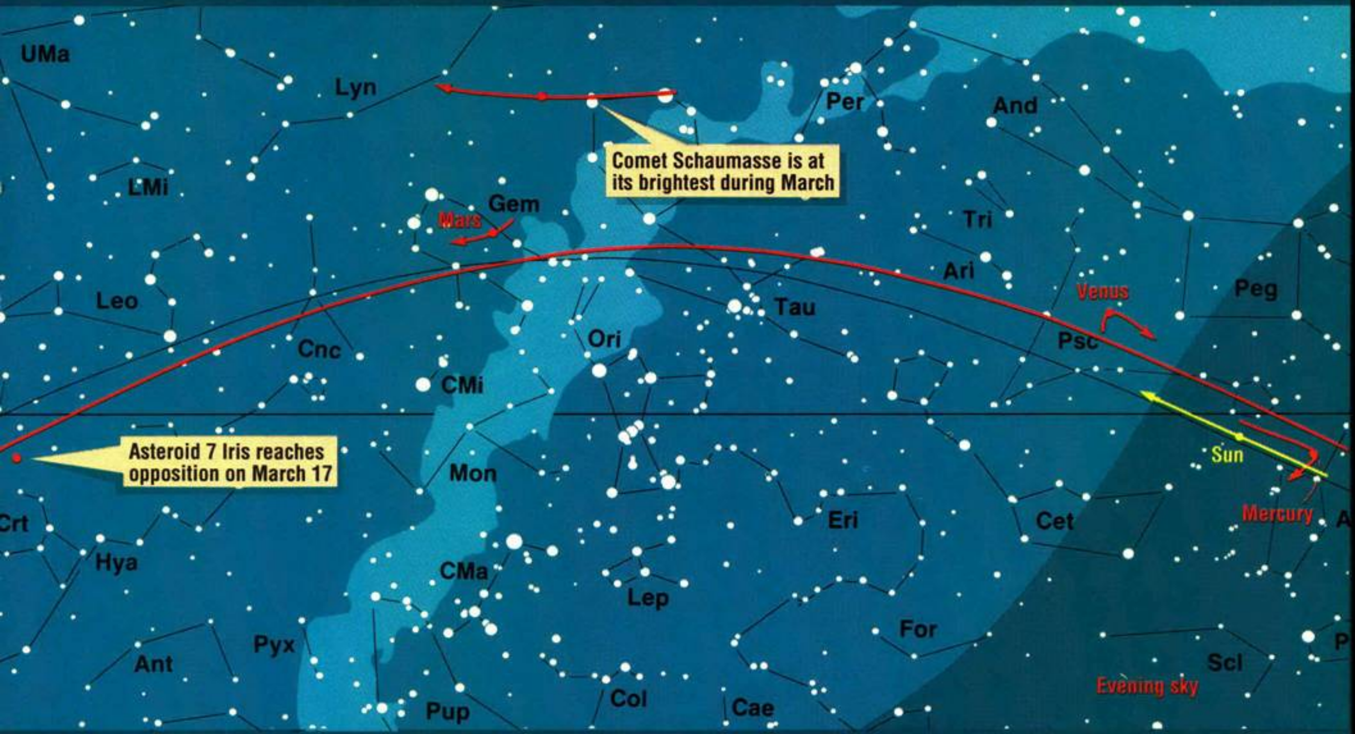


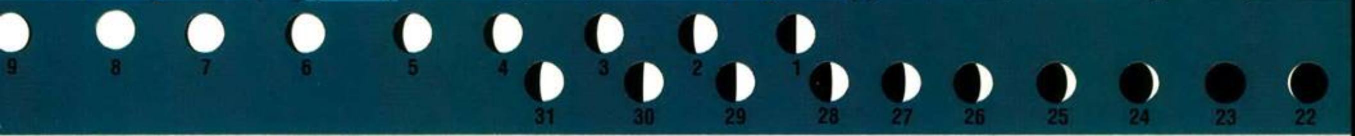
Planet	MERCURY	VENUS	VENUS	MARS
Date	March 31	March 1	March 15	March 15
Magnitude	0.6	−4.6	−4.5	0.2
Angular Size	8.4"	41.7"	51.6"	8.9"
Illumination	40%	23%	11%	91%
Distance (AU) from Earth	0.797	0.400	0.323	1.049
Distance (AU) from Sun	0.463	0.719	0.719	1.657
Right Ascension (2000.0)	23h00.5m	0h58.1m	1h01.5m	6h57.3m
Declination (2000.0)	−7°23'	+12°09'	+14°45'	+25°43'

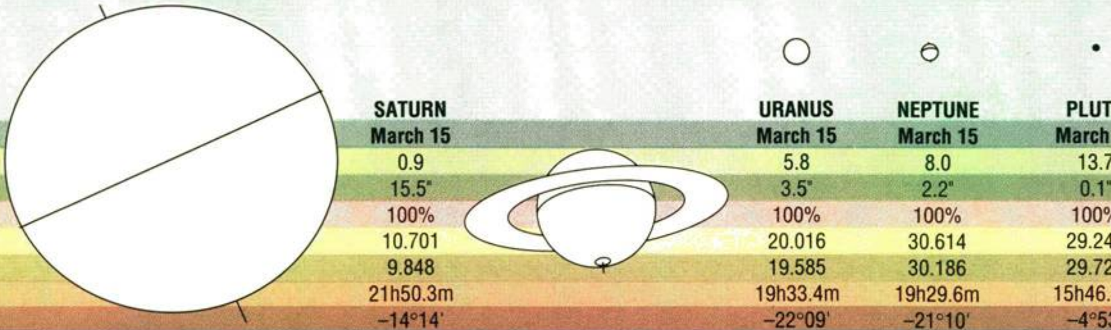
Jupiter's Moons

Dots display positions of Galilean satellites at 5 UT on date shown. South is at top to match the view in a telescope.



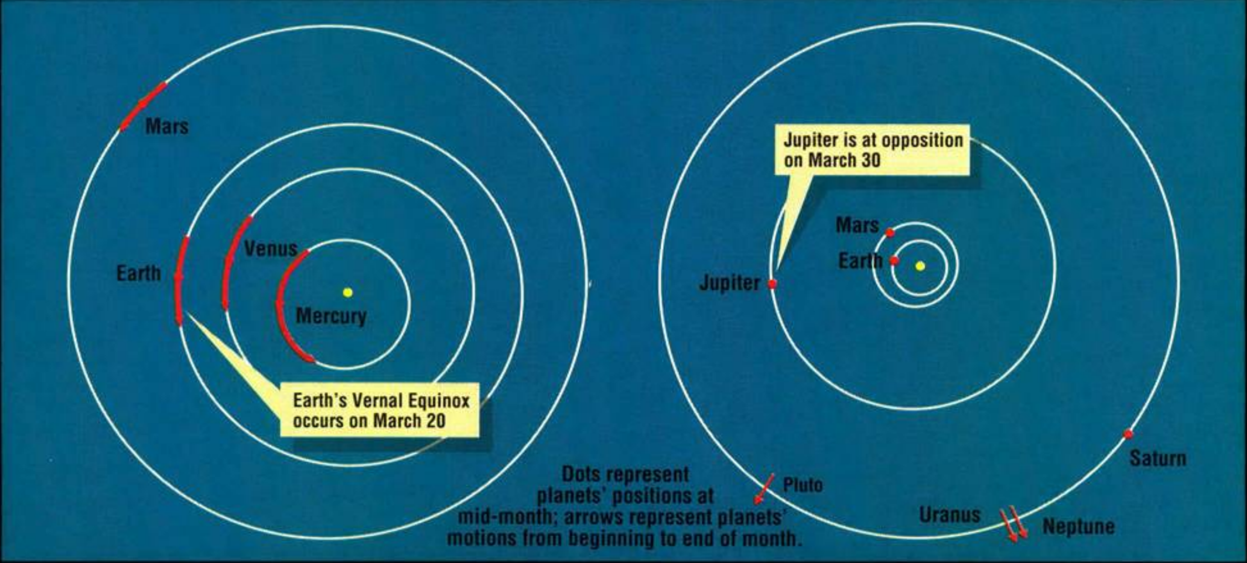

UMa
Lyn
Per
And
Comet Schaumasse is at its brightest during March
LMi
Gem
Mars
Tri
Ari
Leo
Tau
Venus
Peg
Cnc
Ori
Psc
CMi
Asteroid 7 Iris reaches opposition on March 17
Mon
Sun
Mercury
Crt
Eri
Cet
Hya
CMa
Lep
For
Ant
Pyx
Scl
Evening sky
Pup
Col
Cae


9
8
7
6
5
4
3
2
1
31
30
29
28
27
26
25
24
23
22



JUPITER	SATURN	URANUS	NEPTUNE	PLUTO
March 15	March 15	March 15	March 15	March 15
–2.4	0.9	5.8	8.0	13.7
43.8"	15.5"	3.5"	2.2"	0.1"
100%	100%	100%	100%	100%
4.495	10.701	20.016	30.614	29.248
5.452	9.848	19.585	30.186	29.727
12h45.9m	21h50.3m	19h33.4m	19h29.6m	15h46.7m
–3°13'	–14°14'	–22°09'	–21°10'	–4°53'

The Planets in Their Orbits


Mars
Earth
Venus
Mercury
Earth's Vernal Equinox occurs on March 20
Jupiter is at opposition on March 30
Mars
Earth
Jupiter
Saturn
Pluto
Uranus
Neptune

Dots represent planets' positions at mid-month; arrows represent planets' motions from beginning to end of month.

Since 1975

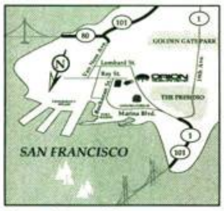
America's #1 Source For Telescopes, Binoculars & Accessories

Fast SAME DAY Shipping on phone orders received by Noon Pacific Time. Safe *guaranteed* shipping to anywhere in the USA and Canada!

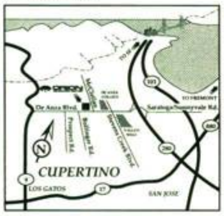
CALL TOLL-FREE 800-447-1001
IN CALIFORNIA: 800-443-1001

When You're in the San Francisco Bay Area, Visit One of Our Three Unique Retail Stores.

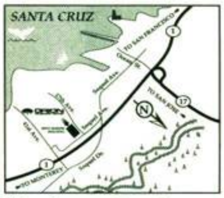
America's biggest & best selection of telescopes, binoculars & accessories. Now 3 convenient Northern California locations!



San Francisco
1 block from Marina Safeway
3609 Buchanan St., at Bay
415/931-9966



Silicon Valley/ San Jose/Cupertino
10555 S. DeAnza Blvd., at McClellan
From Hwy 280 take Cupertino exit, south 1.5 miles on DeAnza, from Los Gatos take Hwy 9 to Saratoga-Sunnyvale Rd.
408/255-8770



Monterey Bay/ Santa Cruz
2450 17th Ave., West Marine Building,
From Hwy 1, take Soquel Drive exit,
1/2 block from the freeway at Soquel Avenue
408/464-0465

NEW SURPLUS CENTER
Now Open at our Santa Cruz Location Only

Great deals on one-of-a-kind telescopes, binoculars & accessories—product samples, prototypes, store display models, returned and discontinued items—many in brand new condition, many at or below cost. *(Retail Store only. Sorry, no phone orders.)*

Orion is Your #1 Source for CELESTRON Telescopes, Binoculars and Accessories

If you are thinking about buying a Celestron telescope, Orion is the place to buy it. We've sold thousands of Celestron telescopes to amateur astronomers across the USA. Our low, low prices and special accessory packages can really save you a bundle! Whether you are considering a big telescope or a small one, or a binocular or accessory, chances are Orion has just what you are looking for. And we probably have it in stock for immediate delivery, too!

Celestron telescopes are available with a variety of mounts, including German-style equatorial or fork mounts, with a wide range of available drive systems including the renowned CompuStar computer-controlled mount. A huge selection of models up to 14" in aperture, in all price ranges, available for immediate delivery!

Schmidt-Cassegrains—Celestron pioneered these fantastic instruments, and has an enviable reputation for building unsurpassed, exquisitely fine Schmidt Cassegrain optical systems.

Refractors—Celestron's wide range of refractor models covers the full range of apertures where the refractor is well suited to portable use, up to 102mm diameter. Models include the incredible 102mm Fluorite apochromat, ideal for the advanced refractor enthusiast.

Reflectors — Celestron's popular reflector telescopes feature superb optical performance and full-featured, precision equatorial mounts which permit a full complement of optional accessories including electronic drive systems.

ORION TELESCOPE CENTER

FREE GIANT COLOR CATALOG — *Write or Call Toll-Free Today!*
Packed with a huge selection of quality telescopes and accessories. Orion has the world's largest selection of the finest quality telescopes, binoculars & accessories, all at low discount prices! Hundreds of exclusive items you won't find anywhere else.
Only a small selection of our products are in this ad! Be sure you have our catalog.

✧ Sirius™ Plössl Eyepieces!

Fantastic Name-Brand Quality Eyepieces at an Incredible Low Price!

Only $59.95 each (3.45)

Set of 4 in foam-lined case $219 (4.71)

NEW!!
PLÖSSL 25mm FULLY COATED
Sirius
PLÖSSL 7.5mm FULLY COATED
PLÖSSL 10mm FULLY COATED

You could pay nearly twice the price for 'famous name' Plössl eyepieces, but you won't be able to tell the difference when you look through these fantastic eyepieces!

Sirius Plössls are top-quality, 50° apparent field eyepieces with extremely sharp images of impressively high contrast. Ideal for all types of reflector, refractor and catadioptric telescopes. The Plössl design is renowned for its fantastic performance and has in recent years become the standard by which all other eyepieces are compared.

Each eyepiece is of the classic 4-element Plössl design. Every air-to-glass surface is fully Magnesium Fluoride anti-reflection coated. All lens edges are blackened in the same way as expensive military optics, to further eliminate any scattering of stray light and to maximize contrast.

The optics are mounted in precision black anodized aluminum housings with chrome-plated brass 1.25" barrels for durability and precision fit.

We guarantee that you'll be impressed with the performance of the Sirius Plössls, even when compared to the more expensive name-brand Plössls.

25mm	#8530
17mm	#8531
10mm	#8532
7.5mm	#8533
Set of 4	#8534

MONEY BACK
If you are not completely satisfied with your purchase from Orion, for any reason,
100% SATISFACTION
Just return it in new condition within 30 days after delivery for a full refund.
GUARANTEE

Huge Selection of Astronomy Binoculars

50mm Observer™ Binoculars

Fine quality, moderately priced binoculars, excellent for both astronomy and daytime observation. Fully coated optics, rugged ribbed rubber covering for a good grip. Both have a 7° field of view.

7x50 #9620, **$79.95** (4.44)
10x50 #9623, **$89.95** (4.44)

50mm Explorer™ Binoculars

Our newest high performance binoculars with BAK-4 prisms and Multi-Coatings. Great for both astronomy and daytime observation. Comfortable ergonomic body design.

7x50 #9306, **$109** (4.44)
10x50 #9308 **$119** (4.71)

50mm Adlerblick Binoculars

Incredible wide field eyepiece design, Fully Multi-Coated, BAK-4 prisms, and best special glass objective lenses make the 7x50 Adlerblick the arch rival of European brand binoculars selling for 3-4 times the price. Orion buys direct, saving you money. Includes deluxe hard case, lens caps and straps.

7x50 #9612 **$279** (5.28)
10x50 #9610 **$269** (5.28)

Orion® 8x56 Mini Giants

56mm objective lenses gather over 2.5x the light of ordinary 7x35 binoculars. Perfect for viewing faint celestial objects, daytime viewing. Best Multi-Coated BAK-4 optics. 6° field of view. Standard model 33 oz. Rubber Armored for protection from bumps. Weighs 37 oz.

Rubber Armored Model #9627 **$149** (5.07)
Standard Model #9504 **$139** (4.71)

Orion® 70mm FMC Giants

The standard for hand-holdable astronomy binoculars. Fully Multi-Coated. 33% lighter—weighs only 58 oz.—yet the same brightness and 7mm exit pupil as our 11x80 MC model. Superior 'BCF' body design. Includes: soft rubber eyecaps, tripod mounting adapter, durable hard carrying case, lens caps and straps.

10x70 #9501 **$299** (6.97)
NEW! 14x70 #9594 **$299** (6.97)

NEW! 10x70 Waterproof Binoculars

Light enough to hand hold, yet powerful enough to bring in remarkable views of deep space celestial objects. With military-grade optics, for the highest degree of optical accuracy and mechanical ruggedness. Will last through a lifetime of use, even under the most extreme environmental conditions. Absolutely waterproof and fogproof. With built-in folding rubber objective lens shades/dew caps. Includes deluxe case, photo tripod adapter. 7mm exit pupil. 5° field of view.

#9309 **$444** (7.29)

80mm FMC Giant Binoculars

20% more light transmission than ordinary "fully coated" binoculars. Fully Multi-Coated optics and superior BAK-4 prisms provide fantastic contrast and greatly improved edge sharpness.

11x80 MC- Brightest, widest field available. Ideal for deep-space observation under dark skies. Hand-holdable.
#9502 ~~$369~~ **SALE! $349** (8.05)

16x80 MC- 45% higher power, excellent for astronomy and daytime observation. Tripod recommended.
#9496 ~~$379~~ **SALE! $359** (8.05)

20x80 MC- Highest power model perfect for smaller deep-space objects and long range daytime views. Tripod required.
#9498 ~~$389~~ **SALE! $369** (8.05)

SuperGiant™ 100mm Binos

Gigantic, almost 4" lenses gather 156% of the light of 80mm binoculars. Individual eyepiece focus, fully Multi-Coated optics and BAK-4 prisms. Tripod mounting plate, metal-clad case. Weight 7.5 lbs., height 13.5".

14x100 #9495, ***25x100*** #9497 **$888** (17.12)

CALL TOLL-FREE
800-447-1001
IN CALIFORNIA: 800-443-1001

IT'S EASY TO ORDER!

- Call Toll-Free and charge to your MasterCard or Visa or send your personal check to order by mail.
- California residents add 7.25% sales tax (8.25% in Santa Clara and Santa Cruz Counties, 8.5% in San Francisco).
- Shipping & handling charge for UPS Ground or US Mail to lower 48 United States are listed in (parentheses) after each price. We ship to U.S. and Canada only.
- We expect the prices in this ad to be accurate for February 1993 at the time of our advertising deadline in December, but are subject to change or correction without notice.

ORION
TELESCOPE CENTER
2450 17th Ave., P.O. Box 1158-A
Santa Cruz, CA 95061-1158
When ordering, mention key code HMA
Business Offices (408) 464-0446

Eyepieces & Barlows

NEW! Orion 70° MegaVista 2" Eyepieces

These new 2" eyepieces offer incredible sharpness to the edge of the wide 70° field. The 7-element design and fully multi-coated optics ensure maximum image contrast and freedom from ghosting. The extra-long eye relief and foldable rubber eyecups make it easy to locate the proper viewing distance—ideal for eyeglass wearers. Compare these new MegaVistas to much more expensive brands—you're sure to be impressed!

34mm #8587 **$199** (3.45)

40mm #8588 **$229** (3.45)

Explorer .965" Eyepieces

Fine quality Multi-Coated eyepieces.

.965" Orthoscopic 5mm #8580, 7mm #8581, 9mm #8582, 12.5mm #8583 **$44.95 ea.** (2.98)

.965" Kellner 18mm #8584, 25mm #8585
.965" Achromatic Huygenian 40mm #8586

$34.95 ea. (2.98)

UltraZoom™ 7–21mm

The finest zoom you can buy for your 1.25" telescope. For astronomy or terrestrial observing. 65°-35° field. Fully coated. #8556 **$149** (3.67)

Superb Ultrascopic™ Eyepieces

Unlike other premium eyepieces, Orion Ultrascopics offer complete multi-layer coatings on ALL surfaces, for superior light transmission and contrast. Modern 5- and 7- element designs for pinpoint star images and breathtaking detail. Wide 52° field of view. Guaranteed to beat other brands selling for much more! Unsurpassed high-performance design!

Medium-High Power 5-element
20mm #8566, 15mm #8568, 10mm #8570, 7.5mm #8572

$74.95 ea. (3.45)

Wide Field 5-element

25mm #8564 **$84.95** (3.45)

30mm #8562 **$89.95** (3.45)

35mm #8560 **$94.95** (3.45)

High Power 7-element *—Long Eye Relief*
5mm #8574, 3.8mm #8576

$79.95 ea. (3.45)

12mm Kellner Illuminated Reticle Eyepiece

12mm Kellner eyepiece with cable plugs into power panel drive bases, and most drive correctors with illuminated reticle output for polar alignment and guiding.
#8482 ~~$69.95~~ **SALE! $59.95** (3.45)

9mm Illuminated Reticle

9mm Orthoscopic eyepiece with wireless adjustable brightness illuminator. Bull's-eye within three concentric circles helps measure limits of acceptable guiding error.
#8488 ~~$119~~ **SALE! $109** (3.67)

Orion® 12.5mm Plössl Illuminated Reticle Eyepiece

This new 12.5mm 4-element Plössl offers unprecedented eye relief and observing comfort during long astrophoto exposures. The battery operated integral illuminator has fully adjustable brightness. Features double crossline reticle.

#8484 ~~$99~~ **SALE! $89** (3.45)

6mm Illuminated Reticle

6mm Orthoscopic design for high power guiding, unique X-Y adjustable reticle positioning for easy guide star alignment. Wireless LED illuminator has adjustable brightness.
#8487 ~~$129~~ **SALE! $109** (3.67)

Orion Plössl Eyepieces

Orion Multi-Coated Plössl eyepieces are fine performers at an amazingly low price. Precision 4-element Plössl lens elements mounted in sturdy aluminum barrels. Available in 12mm, 18mm, or 25mm focal lengths, with 1.25" barrels. Buy all three for less than some single eyepieces!
12mm-#8596; ***18mm***-#8597; ***25mm***-#8598

$42.95 ea. (2.98)

MegaVista™ Wide Angle

Incredible Fully Multi-Coated high-transmission 7-element eyepieces with integral rubber eyeguard and long eye relief.

10.5mm—An incredible 67° field for outstanding planetary or deep space performance.
#8552 **$139** (3.67)

16.8mm—Outstanding high-contrast eyepiece with stunning 70° field ideal for deep space.
#8554 **$139** (3.67)

Orion Accessories

#1 for Quality

#1 for Value

Orion accessories are absolutely guaranteed to be the finest quality available. Compare them side-by-side with "famous name" products! We buy direct from many of the same sources, always specify the highest quality, and pass along the savings to you! 100% satisfaction guaranteed!

Explorer 1.25" Eyepieces

Guaranteed high-performance, Multi-Coated parfocal eyepieces with great performance. Each carefully selected series has been chosen to provide a sensible progression of magnifications. Threaded for filters. Internally blackened to prevent stray light reflections.

Kellner Eyepieces*—Fine Performance*
6mm #8536, 9mm #8538, 12mm #8540, 18mm #8508, 25mm #8510, 40mm #8512

$39.95 ea. (2.98)

Orthoscopic Eyepieces*—Excellent Performance*
5mm #8500, 7mm #8502, 9mm #8504, 12.5mm #8506, 18mm #8524, 25mm #8526

$49.95 ea. (2.98)

Ultrascopic 3-Element Barlow

Fully Multi-Coated 3-Element Barlow lens provides superior imaging with precise color correction at three wavelengths. For maximum light transmission and highest contrast, we have used the finest quality multi-coating on each air to glass surface. 1.25" diameter. #8750 **$59.95** (3.45)

VariPower™ 2-3x Barlow

Fills the gaps in your eyepiece collection. Internal lens cell slides easily to adjust magnification. Quality optics provide excellent sharpness, contrast and brightness. Works with 1.25" diameter eyepieces and right-angle diagonals. #8748 **$52.95** (3.45)

Fully-Baffled Barlow Lens

Fully internally opaqued and baffled to block stray light for noticeably higher contrast. Large 27mm multi-coated 2-element lens provides 2x magnification with any 1.25" eyepiece.
#8746 **$44.95** (2.98)

Filters

Color Eyepiece Filters

Highest quality precision-ground optical glass. Fully anti-reflective coated. Piggyback precision aluminum cells. Solar system observations are dramatically improved by Orion colored filters. Thread one into the barrel of any standard eyepiece. Can also be threaded directly into a universal camera adapter.

.965" Basic Set of 4 Filters Includes #80A Blue, #58 Green, #25 Red, #15 Yellow.
#5510 **$34.95 set** (2.98)

1.25" Basic Set of 4 Filters
Includes #80A Blue, #58 Green, #25 Red, #15 Yellow.
#5514 **$39.95 set** (2.98)

1.25" Expansion Set of 4 Filters
Includes #21 Orange, #47 Violet, #11 Yellow-Green, #82A Very Pale Blue. #5516

1.25" Advanced Set of 4 Filters
Includes #8 Light Yellow, #23A Light Red, #38A Deep Blue, #56 Light Green. #5570

SALE! $29.95 set (2.98)

More Color Eyepiece Filters

Deluxe Set of 8 Filters for 1.25" Includes all the filters in our basic and expansion filter sets.
#5517 **$74.95** (3.45)

Full Set of 12 Filters for 1.25" Includes Basic Set, Expansion Set, Advanced Set.
#5575 **$109** (3.67)

Individual 1.25" Filters- #80A Blue (#11040), #58 Green (#5540), #25 Red (#5536), #15 Yellow (#5532), #21 Orange (#5534), #47 Violet (#5538), #11 Light Yellow-Green (#5530), #82A Very Pale Blue (#5544), #8 Yellow (#5571), #23A Light Red (#5572), #38A Deep Blue (#5573), #56 Light Green (#5574)

$11.95 ea. (2.43)

Moon Filters

Cuts 87% of the light from the Moon. Reduces glare by uniformly reducing light transmitted over the entire spectrum.

.965" #5664 **$13.95** (2.43)

1.25" #5662 **$13.95** (2.43)

SkyGlow™ Light Pollution Filters

Enhance your viewing of faint deep sky objects with the best broadband light pollution filter you can buy. Our SkyGlow absorbs frequencies emitted by city lights, allowing transmission of the rest of the visible spectrum, yielding dramatic results.

SkyGlow Broadband Filters—Photographic and Visual
For use in slight to moderately light polluted areas.

1.25" Broadband Filter–fits 1.25" eyepieces.
#5660 ~~$59.95~~ **SALE! $49.95** (3.45)

Schmidt-Cassegrain Broadband Filter–fits rear cell of Meade & Celestron SC scopes.
#5658 ~~$79.95~~ **SALE! $69.95** (3.45)

52mm Broadband Filter–For 52mm camera lenses, adapter rings available for other diameters.
#5668 ~~$79.95~~ **SALE! $69.95** (3.45)

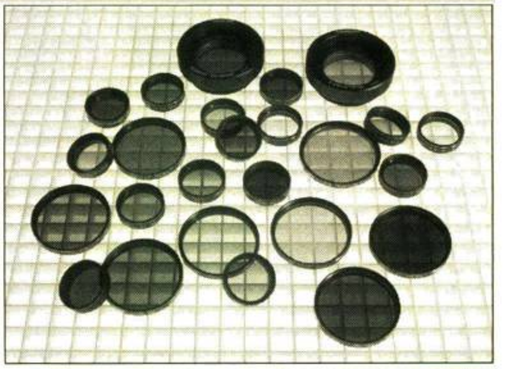
SkyGlow UltraBlock Filters–Visual Only
For severely light polluted areas and faint nebulae.

1.25" UltraBlock Filter–fits 1.25" eyepieces.
#5654 ~~$79.95~~ **SALE! $69.95** (3.45)

Schmidt-Cassegrain UltraBlock Filter–fits rear cell of Meade & Celestron SC scopes.
#5656 ~~$119~~ **SALE! $109** (3.67)

NEW! 2.0" Broadband Filter–
#5659 **$89.95** (3.45)

NEW! .965" Broadband Filter–
#5661 **$39.95** (2.98)



Accessories

See Our Catalog for Even More!

New!
Scope Saver

45° Erect Image Diagonal Prisms

See the world as it really is with Orion's 45° erect image diagonal. Ideal for all refractors and compound telescopes used for terrestrial viewing.

1.25" Diagonal	#8790
.965" Diagonal	#8791
Hybrid Diagonal	#8792

$44.95 ea. (3.45)

Astronomer's Flashlight

Indispensable and indestructible. Has special night-vision red filter and a diffusion lens for even illumination. Requires 2 D batteries (not included).
#5701 **$9.95** (1.79)

NEW! 2" Diagonals

2" Prism Diagonal–Attach 2" eyepieces to your telescope with this high-quality multi-coated prism.
For refractors: #8770
For Schmidt-Cass.: #8771 **$199** (4.71)

2" Mirror Diagonal–Get the widest possible field of view from your telescope with this affordable, high-quality star diagonal.
For refractors: #8773
For Schmidt-Cass.: #8772 **$99.95** (3.45)

Rack & Pinion Focusers

These top-quality focusers are designed for Newtonian reflectors. Fit any size tubes.
1.25" Focuser #13007 **$49.95** (2.98)
2" & 1.25" Focuser #13003 **$84.95** (3.95)

Orion® UltraGuider™

Advanced features at a low price. Use with Meade or Celestron SC. Easily adjustable prism. Ultra-precise helical focus of your eyepiece, adjustable camera focal plane position. #5139 **$109** (4.19)

Orion® Premium Off-Axis Guider

High performance, Multi-Coated, precision anodized. Low Orion price! #5144 **$44.95** (3.45)

Basic Camera Adapters

Combination Eyepiece Projection Tube and Prime Focus Adapter for refractors and reflectors with 1.25" eyepiece holders. Use with T-Ring (sold separately).

.965" #5268 **$29.95** (2.98)

1.25" #5264 **$34.95** (2.98)

Vari-Power Camera Adapter

Unique sliding barrel design allows variable projection distances during eyepiece projection photography, eliminating the need to change eyepieces when magnification changes. #5262 **$44.95** (2.98)

Orion® T-Adapter for SC

For prime focus photography. Use with T-ring to match your 35mm camera. For Meade, Celestron 4", 8", 10", 11", 14" SC. Can be used as 2" camera adapter. #5116 **$27.95** (2.98)

Orion® Tele-Extenders

For high powered photography with your Meade, Celestron 4", 8", 10", 11", 14" Schmidt-Cassegrain.

Standard Tele-Extender #5125 **$27.95** (2.98)

Variable Tele-Extender #5127 **$37.95** (2.98)

Orion® Slow Motion Adapter

Attaches to your photo tripod pan head. 2 slow motion control knobs to make precision adjustments in altitude and altazimuth.
#7012 **$49.95** (2.98)

FlexiShield™ Dew Caps

Eliminate dew problems with FlexiShield! Better performance, more rugged, and easier storage than rigid dew caps. Forms into a tube with the velcro closure, opens flat for easy storage and transportation. Fits your telescope tube snugly, with wide rubber padding and full length velcro closure—needs no screws. Models to fit most telescopes.
8" Celestron/Meade Schmidt-Cassegrains

#4200 **$39.95** (2.98)
Plus nine other models for scopes 3.5" to 14"—Call toll-free!

Orion® Dew Zapper

Orion's Dew Zapper is a sure-fire cure for dew problems on your 8" or 10" Celestron or Meade Schmidt-Cassegrain telescope. Dew Zapper gently replaces lost heat, bringing the corrector plate temperature slightly above air temperature.

8" Dew Zappers —fit all Meade & Celestron 8" Schmidt-Cassegrains
DC Model #3503
AC Model #3504 **$44.95** (2.98)

10" Dew Zappers—fit all Meade 10" Schmidt-Cassegrains
DC Model #3506
AC Model #3508 **$49.95** (2.98)

Dew Remover Gun

Moisture that interferes with viewing dissipates quickly with this 12V DC, 156 watt warm air gun. Has 4-1/2' cord. #5601 **$19.95** (2.78)

Metal-Reinforced Accessory Cases

Keep accessories and camera safe and clean. Diced-foam insert can be tailored to your needs. New black & chrome exterior with sturdy handle, two latches, key lock.

Regular Case: 16"x12"x6.5"
#5920 **$59.95** (7.10)

Large Case: 19.5"x12"x6.5"
#5921 **$69.95** (7.10)

Scope Saver Telescope Covers

Keep your Schmidt-Cassegrain covered and keep the dust and dew away! Fits the telescope either on the tripod or in the case. Blue waterproof nylon fabric. Drawstring closure with cord lock.

8" Model #15130 **$33.95** (2.43)

10"-11" Model Fits Meade 10" and Celestron 11"
#15131 **$39.95** (2.43)
Ask about other sizes.

Deluxe Eyepiece Case

This durable case with double hinges holds up to 10 eyepieces plus barlow. Die cut foam insert for snug fit. O.D. 8-1/2"x12-1/2"x3-1/8".
#5913 **$17.95** (2.78)

Field Tripod Tote Bag

With padded insert to separate wedge from field tripod during transportation. For wedge combinations of Schmidt-Cassegrains up to 10" aperture. Allows storage without changing polar alignment. Tear and mildew resistant blue Cordura nylon.
#15096 **$79.95** (5.19)

Observer's Chairs

Make observing more comfortable and enjoyable with one of these great chairs.

Standard Model—Has adjustable height center column and padded vinyl seat. Folds for easy storage. #5935 **$39.95** (4.70)

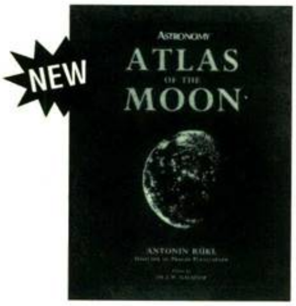
Deluxe Model—Is much heavier-duty, built for professional musicians. Extra thick padding, wide footprint. Adjustable and disassembles for storage.
#5934 **$89.95** (8.02)

12 Amp Hour Porta Pac Battery

Ideal for operating your telescope plus higher power-consuming accessories such as an Orion Dew Zapper. Battery is encased in high impact polystyrene. Carrying case of Cordura nylon with shoulder strap and handle. Wt. 10 lbs. With charger.
#2354 **$109 ea.** (8.97)

LIBRARY OF ASTRONOMY

Beginner



Atlas of the Moon
Thousands of craters, mountains, rays and other features make the Moon a wonderland to explore with a telescope. Includes 76 large-scale maps that portray the entire face of the Moon visible from Earth. Every feature you can see in backyard telescopes is plotted and identified. Perfect for use at the eyepiece. Describes the Moon's origin and history, showcases a gallery of lunar photos, and fully indexes the named features shown on the maps. By Antonín Rükl. 8¼ x 11, 224 pgs., 75+ b&w photos, 190+ diagrams, hrdbd. #18539 .... **$29.95**

Celestial Objects for Common Telescopes, Vols. 1 & 2
This revised, updated edition of a classic observer's manual for viewing the Moon, bright planets and meteors (Vol. 1) and double and variable stars, star clusters and "faint fuzzies" (Vol. 2). Much information of historical interest. By T. W. Webb. Revised. 5½ x 7¾, 606 pgs., approx. 50 b&w photos and hundreds of illus., sftbd. #30001 .... **$12.50**

The Astronomers
The companion volume to the popular PBS TV series, this book is an enjoyable voyage through time and space from the perspective of people who conduct astronomical research. Provides a sweeping look at astronomical discoveries of the past and present, and a look at what lies ahead. By Donald Goldsmith. 7¾ x 9½, 332 pgs., 67 b&w and 36 color photos, 33 illus., sftbd. #30255 .... **$24.95**

David H. Levy
The Sky
a user's guide

The Sky: A User's Guide
The ultimate guide for those just starting out in astronomy. Filled with practical hints and written in a lively, fresh style, this volume will enthuse, entertain and inform you. By David H. Levy. 7 x 10, 295 pgs., hrdbd. #30260 .... **$24.95**

NEW
BINOCULAR ASTRONOMY
CROSSEN & TIRION

Binocular Astronomy
See why most astronomers feel binoculars are an important part of observing. This book, and a pair of binoculars, is all you need to begin exploring the night sky. You'll discover stars, clusters, nebulae, galaxies and much more with a small investment. Includes Wil Tirion's 10-map *Bright Star Atlas 2000.0.* By Wil Tirion and Craig Crossen. 8½ x 11, 224 pgs., 25 color photos, 37 tables, hrdbd. #30262 .... **$24.95**

BEYOND THE SOLAR SYSTEM
ASTRONOMY
100 BEST DEEP-SKY OBJECTS FOR AMATEUR ASTRONOMERS

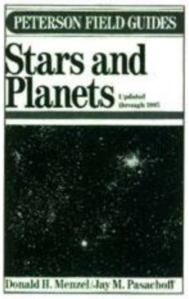
Beyond the Solar System: 100 Best Deep-Sky Objects for Amateur Astronomers
An organized photographic tour of the best and most beautiful 100 star clusters, nebulae and galaxies, including a description of each object's astrophysical nature and extensive observing information. Contains a color portfolio of 21 great deep-sky objects and 105 black-and-white photos. By David J. Eicher, Associate Editor of ASTRONOMY. 8½ x 11, 80 pgs., sftbd. #18535 .... **$12.95**

Norton's 2000.0, 18th Edition
Newly updated. This classic star atlas is a perennial favorite of amateur astronomers. Contains 15 maps showing stars down to magnitude 6 and bright deep-sky objects, plus a 140-page guide to getting started in the hobby of backyard stargazing. Edited by Ian Ridpath. Newly revised. 8¾ x 11½, 179 pgs., hundreds of charts and illus., hrdbd. #30149.. **$41.95**

The Light-Hearted Astronomer
This wickedly funny story of one backyard observer's journey through the hobby. Plenty of how-to advice in between the lines. A must read for anyone contemplating becoming an amateur astronomer. By Ken Fulton. 5½ x 8½, 115 pgs., sftbd. #18001 .... **$9.95**

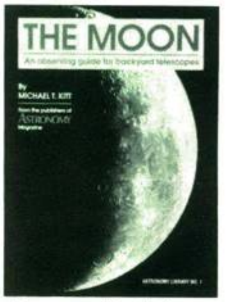
Clyde Tombaugh—Discoverer of the Planet Pluto
An in-depth biography of the only living person to have discovered a planet—Clyde Tombaugh. This book is an appreciation of one astronomer, exploring his feelings, motivations and joys, revealing a man whose life has been dominated by a passion for observing the worlds around him. By David H. Levy. 6 x 9½, 211 pgs., sftbd. #30259 .... **$14.95**

Astronomy with Binoculars
Unlocks the power of a simple pair of binoculars, enabling you to find stars, planets, lunar craters and comets. Includes material on bright deep-sky objects. Illustrated with star maps, photos and diagrams. By James Muirden. 6 x 9, 170 pgs., 11 b&w photos and 65 illus., sftbd. #30015 .... **$8.50**



Field Guide to the Stars and Planets
A handy pocket-size guide. Complete with star charts, sky maps, atlas charts, timetables and advice on viewing. By D. Menzel and J. Pasachoff. 4½ x 7¼, 473 pgs., 150+ b&w and 82 color photos, hundreds of illus., sftbd. #30046........................... **$14.95**

Astrophotography
Astrophotography techniques for beginners! Provides a system for calculating the correct exposures for photographing the Moon, Sun, planets and stars. By Barry Gordon. 2nd Ed. 6 x 9, 208 pgs., sftbd. #30125 .... **$19.95**



The Moon: An Observing Guide for Backyard Telescopes
The first modern observing guide to the Moon. Incorporates geological explanations of lunar features based on Apollo science and includes maps, charts, photographs and diagrams highlighting features you can observe with a small telescope. By Michael T. Kitt. 8½ x 11, 80 pgs., 56 b&w photos, sftbd. #18534 .... **$11.95**

To order call toll free, 24 hours a day

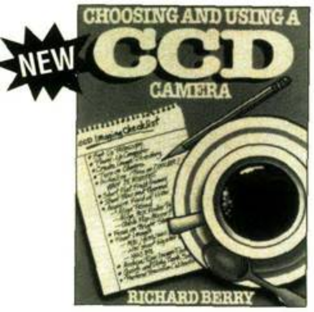
800-533-6644

Please have your credit card ready. Fax 414-796-0126.
Outside the U.S. and Canada call 414-796-8776.

Or use the enclosed order form. Include for postage and handling: U.S. $3.00 for 4th class (or $4.50 for UPS continental U.S. only); Canadian orders add $5.00, other foreign add $10.00. Wisconsin residents add 5% sales tax to total. Canadian orders add 7% GST to total. Payable in U.S. funds. Prices and availability subject to change.

Kalmbach Publishing Co., Dept. AL033, 21027 Crossroads Circle,
P.O. Box 1612, Waukesha, WI 53187-1612

Astrophotography and More



Choosing and Using a CCD Camera

Explore CCD hardware and procedures before making a major investment in equipment. This practical book is designed specifically to help you decide if CCDs are for you. Includes how-tos for successful imaging sessions, plus CCD related software. By Richard Berry. 8½ x 11, 96 pgs., sftbd. #30261 .... **$29.95**

Deep-Sky Photography from Jack Newton

These backyard astrophotos, made with a 20-inch f/5 reflector and Konica 3200 film, rival the best color shots of deep space objects from professional observatories a few years back. Six prints, 11" x 14", show star clusters M13 and M45, nebulae M27, M42, and IC 5067, and the heart of the Virgo cluster of galaxies. #18531 .... **$16.95**

Kim Zussman's Precision Astrophotography

Ten stunning black-and-white art prints, each measuring 11" x 14", show dramatic detail in galaxies M33, M66, NGC 253, and NGC 4565, and nebulae B33, M1, M16, M20, NGC 7293, and NGC 7635. The images, made with a modified 11-inch f/10 SCT and hypered Tech Pan film, depict the state of the art in amateur astrophotography. #18532 .... **$16.95**

The Finest Galaxies

The world's finest images of the best galaxies in the universe collected in a smart set of six color art prints that measure 11" x 14". Includes the spirals M31 in Andromeda, M33 in Triangulum, NGC 253 in Sculptor, and NGC 2997 in Antlia; the barred spiral M83 in Hydra; and the peculiar galaxy Centaurus A. #18530 .... **$16.95**

Flying by the Planets

A series of computer animated "flights" over Venus, Mars, the Earth and the Moon (along with a tribute to the Voyager missions to Jupiter and Saturn). Produced by The Jet Propulsion Laboratory with accompanying text by The Astronomical Society of the Pacific. 35 min. #50004V **$32.95**

PBS HOME VIDEO
THE ASTRONOMERS

The Astronomers Video Series

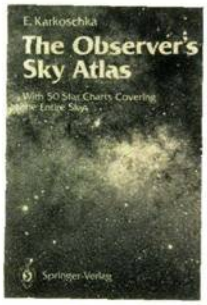
A six-tape series narrated by Richard Chamberlain. *The Astronomers* spans five continents to interview astronomy's newsmakers and examines such cutting edge topics as dark matter, quasars, black holes and the search for planets outside our own solar system. Features state-of-the-art visual effects while focusing on the lives of the scientists. Six tapes, 60 min. each. #50160V **$144.95**

Miller's Planisphere

The standard tool for all levels of observers shows the sky for any day of the year at any hour, allowing you to identify stars and constellations with ease. Available for 30° North and 40° North latitudes. Made from waterproof plastic to withstand years of use. 10½" diameter.

30°N #30190 .... **$9.95**
40°N #30189 .... **$9.95**

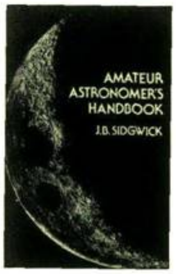
Beginner



The Observer's Sky Atlas

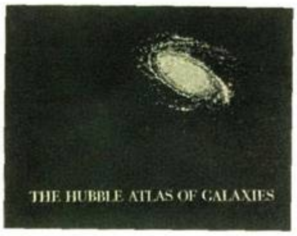
Fifty-seven charts and drawings cover the entire sky down to magnitude 6 and depict the positions of 250 bright star clusters, nebulae and galaxies. Contained within a handy, pocket-sized format that's easy to carry out under the stars. By Erich Karkoschka. 5 x 7½, 130 pgs., sftbd. #30237 .... **$14.95**

Advanced



Amateur Astronomer's Handbook

Comprehensive coverage of telescopes and accessories. By J. B. Sidgwick. 5½ x 8½, 572 pgs., approx. 150 illus., sftbd. #30018 .... **$9.95**



The Hubble Atlas of Galaxies

Photos illustrate Edwin Hubble's famed galaxy classification. From the Carnegie Institution of Washington. 15⅜ x 11½, 51 pgs., hrdbd. #30231 .... **$39.95**

The Meteorite & Tektite Collector's Handbook

Describes how to identify and classify meteorites, their physical characteristics, how to care for them, and where to obtain samples. Includes a glossary and lists of important collections and groups interested in meteorites. 38 photos, 24 drawings and 25 tables. By Philip M. Bagnall. 6¼ x 9¼, 170 pgs., hrdbd. #30252 .... **$24.95**

Planetary Nebulae: A Practical Guide and Handbook for Amateur Astronomers

A detailed observing manual that presents descriptive notes of bright planetaries, a comprehensive catalog of 1,340 objects and 253 finder charts for telescopic observation. Includes a chapter on the astrophysics of planetaries. By Steven J. Hynes. 6⅛ x 9¼, 270 pgs., sftbd. #30253 .... **$24.95**

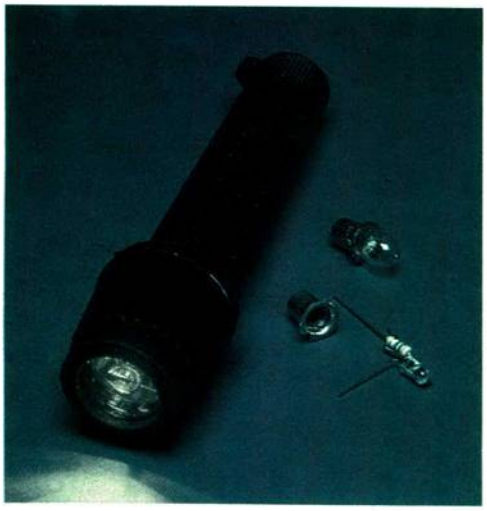
Telescope Optics: Evaluation and Design

A guide to buying or producing your own telescope optics, providing background on lenses and mirrors, telescopic aberrations and types of optical systems, including reflectors, refractors, Schmidt-Cassegrains, Maksutovs and eyepieces. By H. Rutten and M. Van Venrooij. 6¼ x 9¼, 375 pgs., hundreds of charts and illus., hrdbd. #30175 .... **$24.95**

THREE HANDY OBSERVING AIDS

If you can saw wood, cut plastic, or solder two wires together, you can build these simple projects that will make observing easier.

Sometimes simple accessories can increase your enjoyment while observing. Many of these aids needn't cost a lot of money either. Here are three low-cost projects you can build in a spare evening.



ASTRONOMY: photos by Darla Gawelski

AN LED FLASHLIGHT

by Ron Wagner

A red light for reading charts and guide books is necessary to preserve your night vision when observing. The simplest source of red light is a flashlight with a red cellophane or plastic filter. These filters often get scratched or torn, leaking annoying white light. Or they filter too much light. A light emitting diode (LED), however, provides a red light that can't leak white light.

Any two-battery-powered flashlight will provide the basic parts for an LED light. You'll also need a red LED (Radio Shack part number 276-087, about $1.89) and a 47-ohm dropping resistor (Radio Shack #271-009, about $0.29; use a 68-ohm resistor, Radio Shack #271-010, for a fainter glow). Remove the bulb from the flashlight and carefully crush the glass globe with pliers. Remove the wire filament and scrape the cement from the base with a screwdriver or knife.

One wire will remain attached to the base. Remove it by melting the solder knob on the bottom of the base with a soldering iron, as well as any excess solder so the hole is open.

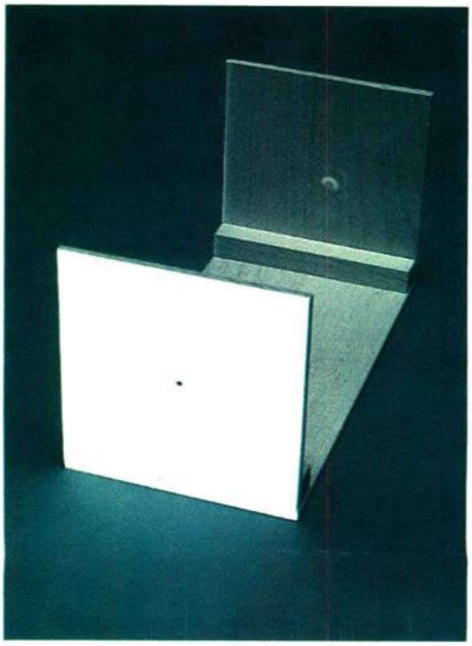
Cut one lead of the resistor $^{1}/_{2}$" long. Bend this lead in a U shape near the resistor body. Cut the anode of the LED (the long lead or the one next to the flat spot on the LED) about $^{3}/_{8}$" long. Solder the anode and the U-shaped lead of the resistor together. Now bend the cathode of the LED into an "L" shape away from the anode lead.

Insert the resistor lead into the hole in the bulb base. The resistor should fit in the base. The L-shaped lead of the LED fits in the notch in the base. When you have the leads positioned, solder each lead to the base. Be quick so the heat doesn't damage the LED. Cut off the excess lead and touch up each solder joint with the soldering iron or with a file. Place the bulb in your flashlight and enjoy its red light the next time you observe.

SUNFINDER

by Marvin Jacoby

Centering the Sun in a filtered telescope or camera viewfinder can be difficult, especially if you're rushing during a total solar eclipse. Your finderscope is of no use because you have capped it to prevent its unfiltered view from permanently damaging your eyesight. Sweeping the sky to find the Sun is frustrating. You could use the shadow generated by the scope, minimizing the shadow to roughly aim the scope at the Sun, but this technique requires some patience and skill — or luck. Instead, try a pinhole camera that I call a Sunfinder.



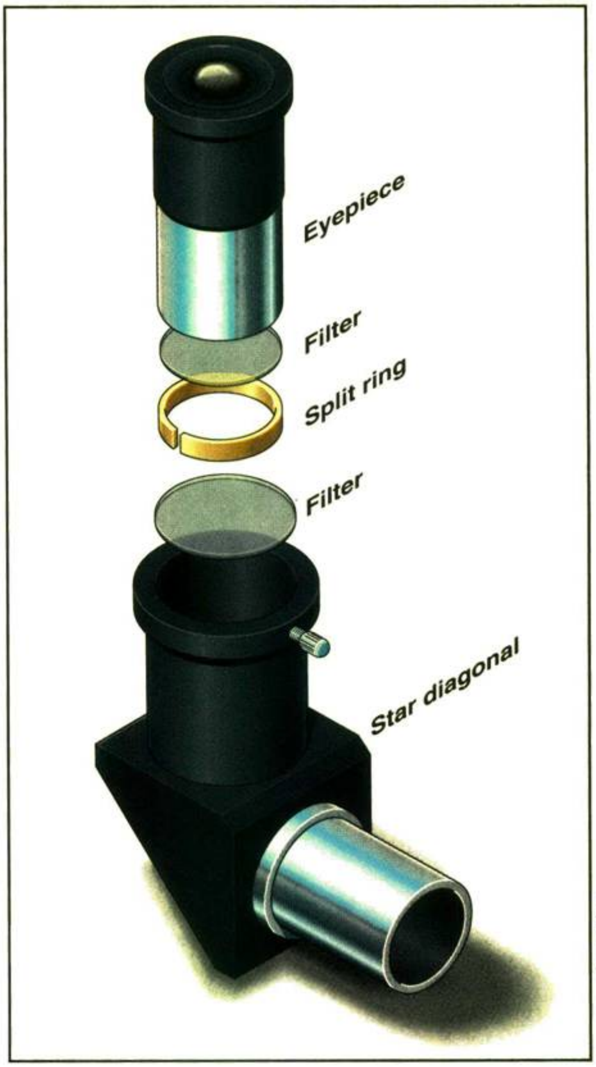
This simple device makes lining up your scope easy by projecting the Sun's image onto a screen marked with a crosshair.

You can build a Sunfinder out of wood or cardboard; its exact dimensions aren't critical. Consider using a hardwood if you live in a damp climate or if you'll use the Sunfinder often. In the photo (below left), 1/8" thick maple forms the bottom and ends. The ends are 3" square and the bottom is 3" by 6". Three-inch lengths of 3/8" square maple brace the glued corners. Drill a hole 1/16" or less in diameter in the center of one end. Diagonal scribe marks on the inside of the other end made with a sharp hobby knife act as crosshairs when aiming the Sunfinder.

To align the Sunfinder, first find the Sun in your scope. ***Be sure your scope is properly filtered.*** (You could also use the Moon, but it may not be bright enough to show the crosshairs.) You can roughly point the scope by making its shadow on the ground as small as possible. Sweep carefully until you see the Sun in the eyepiece. Then tape the Sunfinder to the scope's tube, making sure that the Sun's image appears on the scribe marks. You can then attach the Sunfinder to the tube with screws, if you so desire. The next time you use your scope, simply line the Sun up with the scribe marks and — presto! — you should see the Sun in the eyepiece.

FILTER THE MOON

by James Moeller



ASTRONOMY: Steven Davis

Most Moon filters contain a single neutral density filter that is a single shade of gray or brown glass or plastic. Although they dim the Moon's light, they often provide views of lunar features that are still too bright or too dark.

Some Moon filters improve on this by providing a set of polarizing filters. By turning one filter with respect to the other, you can change how much light gets through the filter (called the filter transmission) and make the brightness of the Moon just right. Unfortunately, many of these filters screw into the bottom of your eyepiece, requiring you to remove the eyepiece to change the filter transmission. When you replace the eyepiece, invariably the Moon's image has shifted and you have to search again for that tantalizing view of the Apennines.

One solution is to place one part of the polarizing filter in a star diagonal. With the other filter on the eyepiece, simply turning the eyepiece in the diagonal changes the filter transmission and the Moon's brightness.

Making your own variable Moon filter is easy. You need two pieces of polarizing glass or optical-grade plastic. And you need some brass tubing to make one or two split rings for your eyepiece. Many science catalogs offer suitable polarizing material — for example, Edmund Scientific sells commercial-grade polarizer (#41,168) for $13.15 and experimental-grade polarizer (#37,348) for $8.50. Or ask your local pharmacy or department store for discarded or defective sunglasses that have plastic lenses. The frames may be broken but if the lenses are in good shape, they'll work just fine for a Moon filter.

Thin polarizing material can be cut with shears or a sharp hobby knife. Thicker material, as found in some plastic sunglass lenses, requires a nibbling tool or a fine jeweler's saw to shape it into a circle. You need two circles, one to fit the inside of your eyepiece and the other, slightly larger, to fit your diagonal. The filters should fit their tubes loosely so they don't become twisted or distorted inside the tubes. Test fit the filter often as you shape it to keep from making it too small or too large.

Be careful in handling the filter material so it doesn't become scratched accidentally or etched by the acids from your skin. I wear rubber gloves when handling the filter material. Also watch the sharp edges when cutting the filters — they can easily cut fingers. Rough out the circular shapes of the filters with the shears, nibbler, or jeweler's saw, and finish the edge with a file or fine-grade sandpaper (warning: loose grit can scratch the lens).

If your eyepiece has an internal stop large enough to support the filter, then you need only one split ring to hold the filter in place. Otherwise you need two rings to keep the filter from moving around inside the tube and possibly getting damaged. Cut the rings from 1 1/4" brass or aluminum tubing, either available directly from your hardware store or in their plumbing section as a sink trap. Use a tubing cutter or a hacksaw to cut the tubing into 1/4"-wide rings. Cut a gap in each ring so you can change the diameter of the ring by pushing the ring together or by pulling the ring apart. File the edges of the rings so there aren't any burrs or sharp edges that will cut you or scratch the filter. If you don't want to dedicate one eyepiece to lunar observing, bend the ring on one side of the gap into an "L" shape so you can remove the ring with needle-nose pliers.

Insert one ring — if necessary — and then the filter in the eyepiece. Hold the filter in place with a split ring. If you used sunglass lenses for your filters, place the hollow side of the filter so it faces the star diagonal. When you're ready to observe, place the other filter in the star diagonal (hollow side facing the eyepiece if you used sunglass lenses). The eyepiece will hold it in place. Now when the Moon is too bright, just twist the eyepiece until you get the right brightness. □

Night of the Deep-Sky Observer

Follow a lone sky watcher through a night of viewing springtime clusters, nebulae, and galaxies.

by Jerry Spevak

Steve Quirk

THE REFLECTION NEBULA M78 in Orion appears as a misty cloud surrounding two bright stars.

Kim Zussman

THE ESKIMO NEBULA in Gemini has a bright central star, easily visible disk, and a nebulous fringe of "fur."

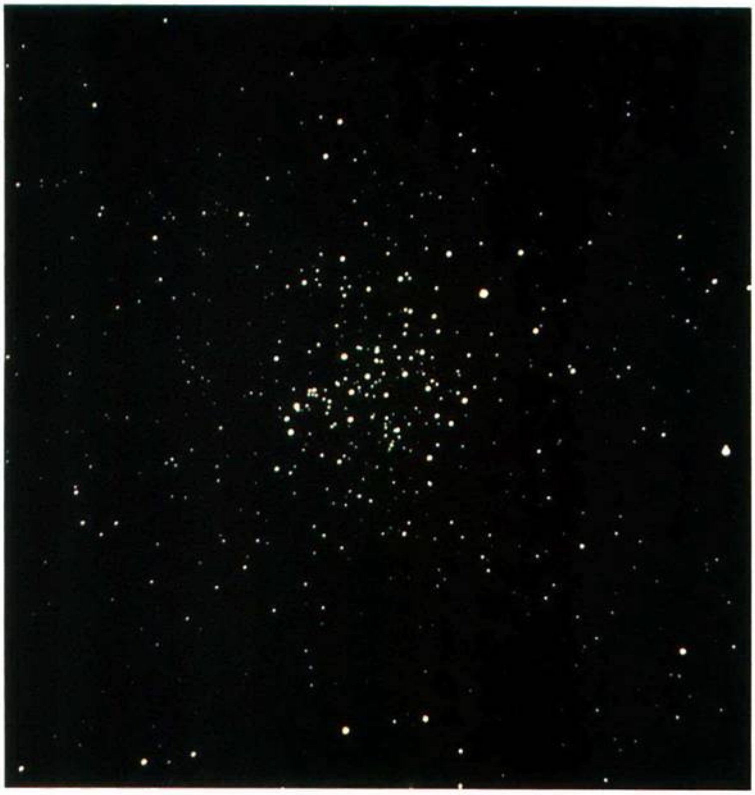
As I drive down the road, the snow and ice stand high on both sides, reflecting the headlights in dancing shimmers and keeping me from even thinking of speeding. It's a strange feeling, like driving through a frozen tunnel on my way to a secret retreat. It's early March and the snowplows have struggled all winter to keep this corridor open, but in places the road now narrows to almost a single lane. I'm winding through Ontario's Algonquin Provincial Park, famous for its many hills, endless canoe routes, and black night skies. Pulling into my observing site I can see the stars of winter shining above the pines and the snow. As I turn off the engine and step outside, the first thing that hits me is the incredible silence. As I survey the steady beacons in Orion and Canis Major I can tell a night of superb observing lies ahead.

This is a special night, one that I can steal from my busy schedule only occasionally, so I waste no time setting up my scope. It's an 8-inch SCT, a standard model that I use as often as I can to probe the vast open space of the Galaxy and universe beyond. Tonight I want to visit some old friends of the winter and spring skies: a few clusters, nebulae, and galaxies that I've come to know very well.

I aim the scope toward the waist of Orion. The target? **M78** (NGC 2068), a reflection nebula — a cloud of dust reflecting starlight just north of the constellation's belt. I plop my low-power eyepiece into the diagonal and star hop over to the right spot. The chill of the night air doesn't faze me — M78 is just visible in my finder as a fuzzy spot. In my 8-inch SCT at 40x, the view is stunning. I can see a bright mottled nebulosity with two stars in it. The irregular northern edge is sharply defined. In the same field, the even-fainter nebula NGC 2071 glows dimly. I switch to high power. At 150x the sky brightness in the field is considerably lower, and even though M78 seems dimmer, I can see far more detail. I can now make out faint outlying areas of nebulosity. The size is about 10' by 8'. The northern edge now shows intricate detail and two ghostly regions (NGC 2064 and NGC 2067) are visible to the west.

Why, you may wonder, is more detail visible at high power? Shouldn't a brighter, low-power image show more detail? If we were talking about a photographic emulsion or a CCD chip, the answer would be yes. But

ASTRONOMY: Alan Dyer



David Ratledge

OPEN STAR CLUSTER M67 in Cancer reveals several dozen bright stars to small-telescope observers.

the eye is different. The rods — the faint-light receptors in our eyes — are organized into larger units called receptive fields. Interaction between cells in a receptive field can help or hurt a visual response. It turns out that typically, large, faint objects or features are easier to detect than small, bright ones. Although the contrast between the sky background and the nebula remains the same at any power you choose, the larger apparent size of the nebula at high power stimulates the eye in an especially sensitive way.

But the minutes are ticking away. I skip over to the **Eskimo Nebula** (NGC 2392) in Gemini, arguably the most beautiful planetary nebula in the winter sky. Named the Eskimo because of a nebulous ring of "fur" that surrounds the central disk ("face"), the object is bright enough to see with any telescope. Tonight the view is breathtaking. Still at high power, I center this sapphire in the field of view. What strikes me most is the richness of the field. It's really not surprising since we are now looking right into the Milky Way. The Eskimo Nebula is very bright and with direct vision, I can easily see its blue-green color. As I stare at it the 10th-magnitude central star jumps out of the eyepiece. Averted vision, glancing off to the side of the field, reveals a fainter ring of nebulosity surrounding the main glow and seems to make the central star disappear. This technique lets you use the rods in your eye to maximum effect. With direct vision the star pops back into view. But averted vision shows you so much nebular light it overwhelms the star.

I decide to pop in a nebula filter. These marvels of modern technology have opened up a whole new world of observing. They enhance contrast by transmitting the nebular light and blocking as much other light as practical. Tonight I'm using an O III filter, a proven performer for planetary nebulae. With the filter in place, the Eskimo resembles an observatory photograph. I can see dark patches in the central core, and the ring of nebulosity that was formerly a faint smudge is now transformed into a latticework of radial filaments. Unfortunately, the filter also blocks starlight, and the field is no longer as beautiful.

By now I'm revved up. Not only are my eyes getting used to the dark, my ears are getting used to the silence. The forest is full of the rustle of trees, the whistle of the wind, and the hoot of owls. I now look at the big open star cluster **M67** (NGC 2682). First to the Beehive, down to Alpha Cancri and over a bit . . . *there*. The cluster fills my high-power field. Countless stars are visible, both bright and dim. Dark lanes run in every direction and I can see many tight little groups of stars within the cluster. At low power, M67 appears more concentrated, but fewer stars are resolved. The cluster looks a bit nebulous.

It's getting late and the winter stars are setting in the west. My hands and feet are getting cool, but I want to hang in for a while yet. Staying warm is a concern for

Chuck Vaughn

THE HERCULES CLUSTER is one of the most impressive globular clusters in the sky. A 3-inch scope resolves its edges.

Bill Hood

BRIGHT ENOUGH FOR BINOCULARS, the Whirlpool Galaxy is a prime example of spiral structure, which is visible in a 6-inch scope.

observers, as any discomfort will greatly affect what you can see. If you're chilled, expect to lose a magnitude or more in your vision capability. In temperate climates, dress for the arctic. When you're out observing you simply stand around all night, and your body radiates heat like crazy. Wear heavier clothes than you think you'll need and be absolutely sure you wear a hat — more than 50 percent of your heat loss occurs from your head.

The sky is now turning toward the bountiful crop of springtime galaxies. Of all the spiral galaxies, the **Whirlpool Galaxy** (M51, NGC 5194) exhibits the most easily visible spiral arms. On especially good nights I always find it in hopes of making out details I've never seen before. The Whirlpool is easy to find by hopping down from the end of the Big Dipper's handle. As I center it in my high-power field, I know I've been blessed with exceptional transparency tonight. M51 is full of detail. The spiral arms are prominent, each arm winding more than halfway around the core. The galaxy that is interacting with it, NGC 5195, is quite large and obvious, with a mottled core and a stellar nucleus. The two galaxies are surrounded by a faint glow that I've seen only in photographs before. It's an inspiring sight.

It's really late now, and the **Hercules Cluster** (M13, NGC 6205) is finally rising toward the meridian. At 150x the cluster appears resolved to the core. Many of its members are quite bright, and the range of stellar magnitudes is impressive. Outlying stars form chains that reach north and south. Overall, the cluster more than half fills the 32' field. On the eastern edge of the cluster it's easy to make out three dark lanes that radiate out from a common center. Amazingly, these lanes are oriented nearly 120° apart. The neighboring galaxy NGC 6207 is easily visible to the north. Indeed, I can make out some mottling around the core of this faint spiral.

A couple more long looks at M51 and then it's time to pack it in. We're under the influence of a large high pressure system, and tomorrow's another night. Getting out again, even if it's only to see some old friends in the winter and spring skies, fills me with renewed enthusiasm. A flood of memories of observing sessions past and people I've met under the stars comes back to me. I lose the feeling I sometimes get during the hectic week, and rediscover why I love the stars. Observing all seems so natural, so real, so obvious. How could it possibly be any other way? ☐

Jerry Spevak is an observer living in Richmond Hill, Ontario. He cowrote "ASTRONOMY Tests Ten Nebula Filters" in the February 1991 issue. In the past he also contributed to Deep Sky *magazine.*

Exploring the Spring Sky

Go outside on a cool spring evening and watch lions roam the sky and a vast serpent slither by a fair maiden.

by Deborah Byrd

When spring comes, the days grow softer. Tiny green buds appear on the trees, and new plants push up into the sunlight. Darkness seems unwilling to fall; night comes later now. The season of renewal, spring is also a time for renewed fascination with the night sky. With the coming of warmer weather, you can relax a bit as you recline outside after dark and enjoy the stars.

In March, the winter constellations still dominate the western half of the sky during the evening hours. Try looking southwestward first for one of the largest and most recognizable star figures. Orion the Hunter is the only constellation with two 1st-magnitude stars. Reddish Betelgeuse marks the Hunter's right shoulder, and blue-white Rigel marks his left knee. Be sure to notice the contrast in the colors of these stars.

Betelgeuse and Rigel lie on either side of Orion's Belt, which consists of a short, straight line of three 2nd-magnitude stars. From east to west, these stars are Alnitak, Alnilam, and Mintaka. The three Belt stars are all exceedingly distant. They lie an estimated 1,400 light-years away, in the direction opposite the center of our Milky Way Galaxy. Betelgeuse and Rigel lie in the same direction but somewhat closer at about 600 and 800 light-years, respectively.

From the Belt hangs a curved line of stars. This is Orion's Sword, which you'll see contains a fuzzy "star" in

LEO THE LION contains a sickle, or backward question mark, with Regulus, the lion's heart, at its bottom.

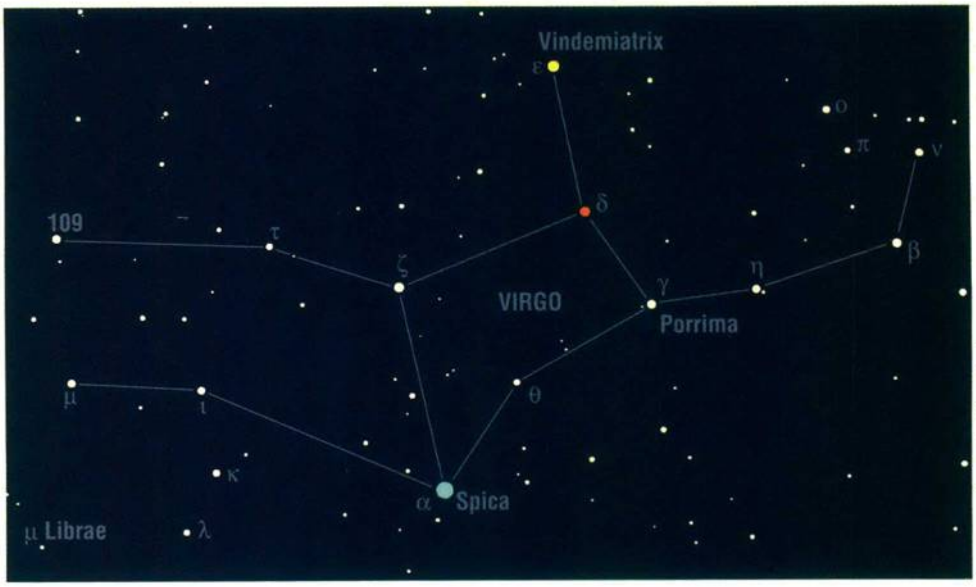
Daniel J. McGlaun, Jr.

the middle. Binoculars reveal this bit of fuzz to be the famous Orion Nebula, a shining cloud of gas and dust and a signpost of renewal in our Galaxy. The nebula started as a dark cloud, one of many such clouds in the Galaxy. Light emitted by its newly formed stars provides the energy that makes its gas glow. Behind this lighted cloud there is a huge dark nebula, where other new stars are being born. This and other hydrogen gas clouds are no longer pristine, but instead contain material ejected into space — either violently in supernova explosions or more gently as stars discard their outer layers — as part of the normal process of stellar evolution and death. Thus the Milky Way's older generation of stars contributes raw materials for new stars, planets, and stargazers.

If you go back to the Belt of Orion and draw an imaginary line from it to the right, you'll come to another bright reddish star. This is Aldebaran, the fiery red eye of Taurus the Bull. Aldebaran appears as part of a V-shaped pattern of stars called the Hyades. It's easy to imagine the face of the Bull in the Hyades stars.

Unlike most starry patterns on the sky's dome, the Hyades is really a cluster of stars bound by mutual gravity. This cluster formed perhaps 600 million years ago in a cloud like the Orion Nebula. Aldebaran isn't part of the cluster, but lies between the Hyades stars and us. Another star cluster in Taurus marks the Bull's shoulder. The Pleiades, or Seven Sisters, is one of the best known sights in the sky. It is extremely compact and has the shape of a tiny dipper. Many people see only six stars in the Seven Sisters — Alcyone, Maia, Electra, Merope, Taygeta, and Asterope. The missing Pleiad is Celaeno, which is too faint to see unless you're at a dark-sky site. Both the Hyades and the Pleiades are good targets for your binoculars, which will reveal dozens of stars in each cluster.

Extending the line through Orion's Belt in the opposite direction, you will come to Sirius the Dog Star, an exceedingly brilliant star. At magnitude –1.5, it is the brightest star in the sky. Sirius appears in the constellation Canis Major, the Greater Dog, a distinctive upside-down Y-shaped pattern of stars that is topped by a straight line. Northeast of Sirius you'll find the Little Dog Star, Procyon, in the constellation Canis Minor, the Lesser Dog. It shines at about magnitude 0.4 because it is one of the stars closest to the Sun at 11 light-years away. Sirius is even closer — only 9 light-years away.



ASTRONOMY: all maps by Steven Davis

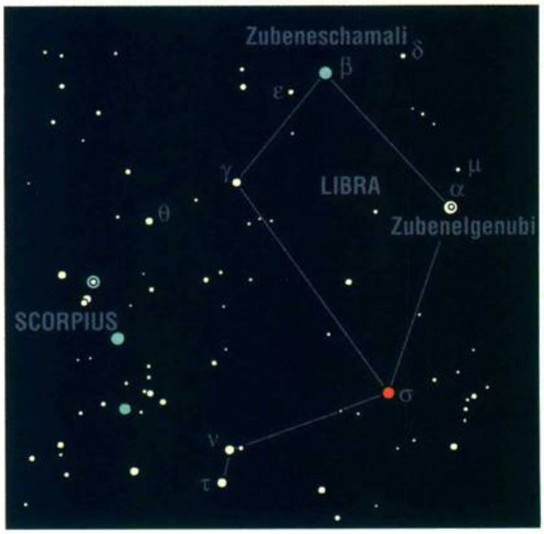
VIRGO THE MAIDEN graces the sky as she holds a palm branch in her right hand and a spica, or ear of wheat, in her left.

With a mighty Hunter, Dogs, and a stamping Bull in this region of the heavens, you wouldn't expect to find creatures known for their timidity. Yet shy Monoceros, the Unicorn, can be found between the two Dogs. Its brightest star glows faintly at about magnitude 4. Lepus the Hare lies motionless at the feet of its hunter, Orion. And below Lepus is Columba the Dove. The Dove was released from nearby Argo Navis, a defunct constellation representing the ship of Jason and the Argonauts that is now divided into Vela the Sail, Puppis the Stern, and Carina the Keel.

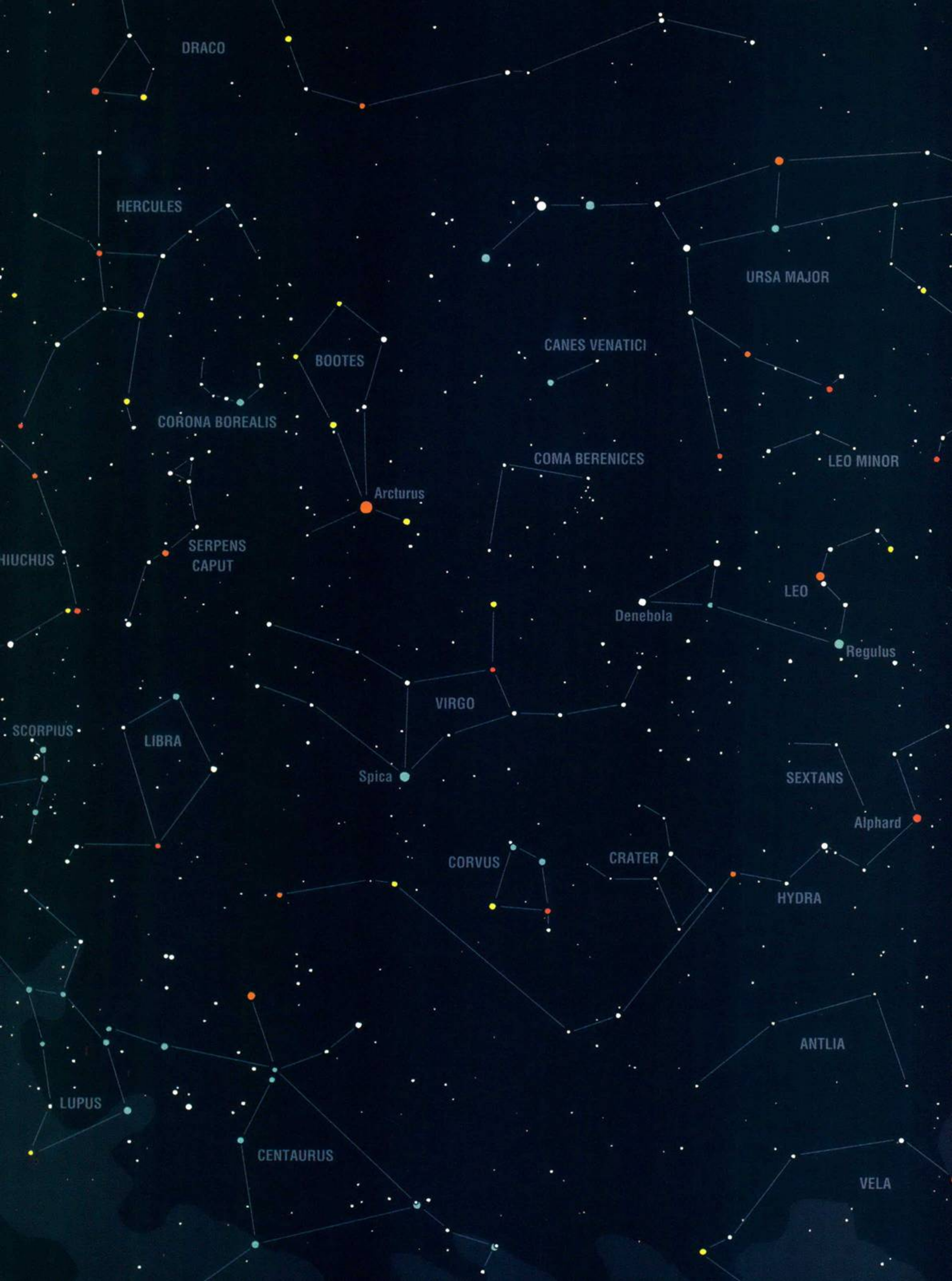
Other bright stars lie in the west on spring evenings. Castor and Pollux in the constellation Gemini the Twins are noticeable not only for being bright but also for being close together, separated by about 5 degrees. Pollux, the immortal twin, shines with a golden light while Castor, the mortal of the pair, appears white. At magnitude 1.1, Pollux is slightly brighter than 1.6-magnitude Castor. These two stars represent the eyes of the twins. The rest of Gemini extends away from Castor and Pollux toward Orion in two roughly parallel streams of stars.

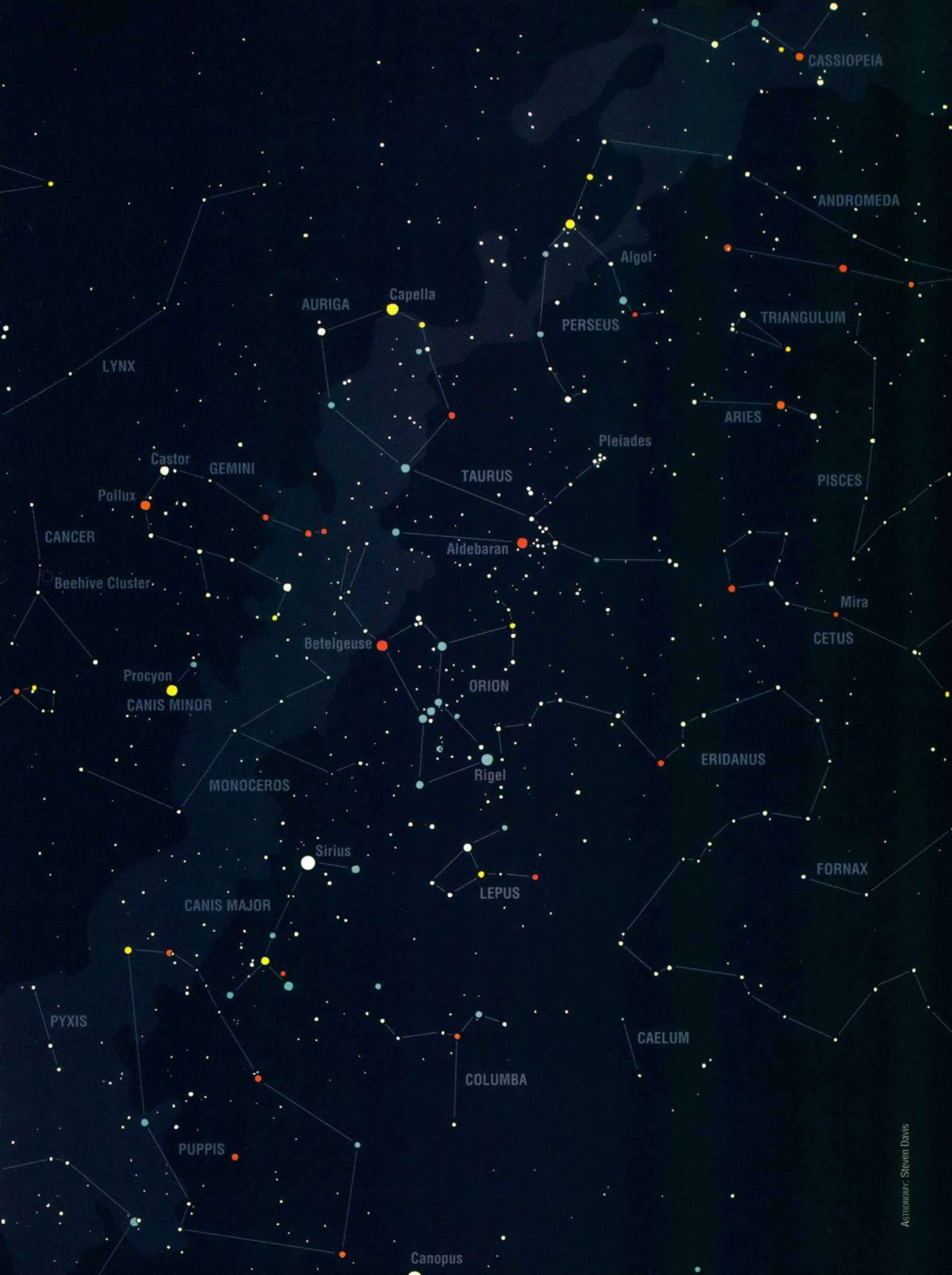
The constellation Auriga the Charioteer is a five-sided figure northwest of Gemini. Auriga's brightest star is Capella the Goat Star. A tiny asterism (recognizable pattern of stars) lies slightly southwest of Capella. It's called The Kids and consists of three stars in a triangle. The Charioteer carries Capella and the Kids on his left shoulder.

LIBRA THE SCALES balances nightly from the star Zubeneschamali. Ancient Greeks thought of Libra as the claws of Scorpius the Scorpion.

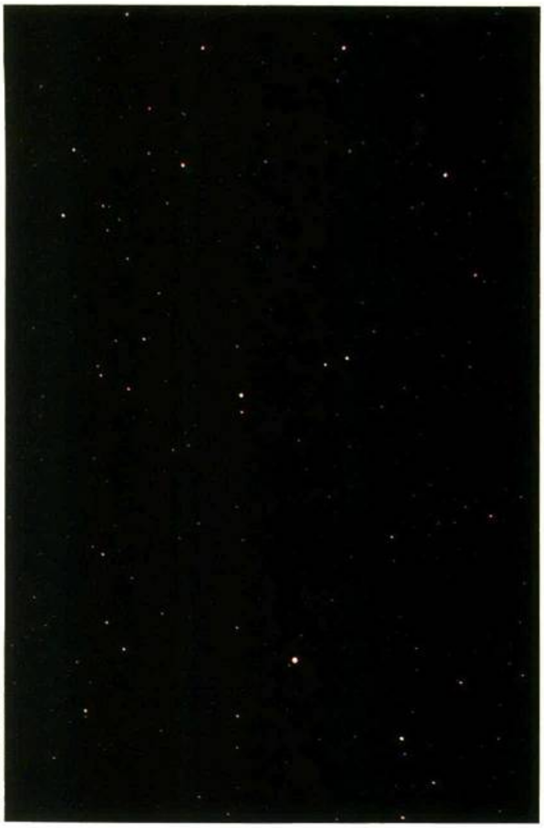


A very large asterism called the Winter Circle extends over much of the western sky on spring evenings. It starts with the bright stars Rigel and Betelgeuse and loops to Aldebaran, then Capella, Castor, Pollux, Procyon, and Sirius. The Winter Circle will descend in the west after sunset as the weeks pass. If you're lucky, you might see a lovely sight gracing the heavens after sunset in April or May. When the Winter Circle is above the horizon after sunset, you


DRACO
HERCULES
URSA MAJOR
BOOTES
CANES VENATICI
CORONA BOREALIS
COMA BERENICES
LEO MINOR
Arcturus
SERPENS
CAPUT
HIUCHUS
LEO
Denebola
Regulus
VIRGO
SCORPIUS
LIBRA
SEXTANS
Spica
Alphard
CORVUS
CRATER
HYDRA
ANTLIA
LUPUS
CENTAURUS
VELA


CASSIOPEIA
ANDROMEDA
Algol
Capella
AURIGA
PERSEUS
TRIANGULUM
LYNX
ARIES
Pleiades
Castor
GEMINI
TAURUS
PISCES
Pollux
CANCER
Aldebaran
Beehive Cluster
Mira
CETUS
Betelgeuse
Procyon
CANIS MINOR
ORION
ERIDANUS
Rigel
MONOCEROS
Sirius
FORNAX
LEPUS
CANIS MAJOR
PYXIS
CAELUM
COLUMBA
PUPPIS
Canopus

ASTRONOMY: Steven Davis



Daniel J. McGlaun, Jr.

ARCTURUS MARKS the bright bear watcher, in the kite-shaped Bootes the Herdsman. You can arc to Arcturus from the handle of the Big Dipper.

might find a crescent Moon in its midst. This is a wonderful marriage of an ending with a beginning. As the Winter Circle leaves the sky for another season, the young Moon returns to wax again toward Full.

Before your attention leaves the western half of the sky, look for the constellation Cancer the Crab. Appearing just east of Gemini, it will be more or less overhead on spring evenings. It's somewhat inconspicuous, with no stars brighter than magnitude 3.5. You can easily imagine the Crab's being overlooked by Hercules, whose mighty deed of stepping on it and squashing it earned Cancer its place among the stars. A dark sky or binoculars will reveal the Beehive star cluster in the middle of this constellation.

The Beehive is called Praesepe and also M44 because it's the 44th object in Charles Messier's catalog. It contains several hundred stars, and the combined light of all the stars makes the Beehive appear as a diffuse glow to the naked eye. Binoculars or a small telescope will reveal dozens of stars.

Like Taurus and Gemini, Cancer is one of 12 constellations of the zodiac. You'll find the Sun, Moon, and planets somewhere along this imaginary "pathway of animals." East of Cancer is the zodiacal constellation Leo the Lion. A recognizable asterism in Leo, called The Sickle, has the shape of a backward question mark. The bright star at the bottom of the question mark is Regulus the Little King, also called the heart of the Lion. It shines at magnitude 1.4 from an estimated distance of 90 light-years.

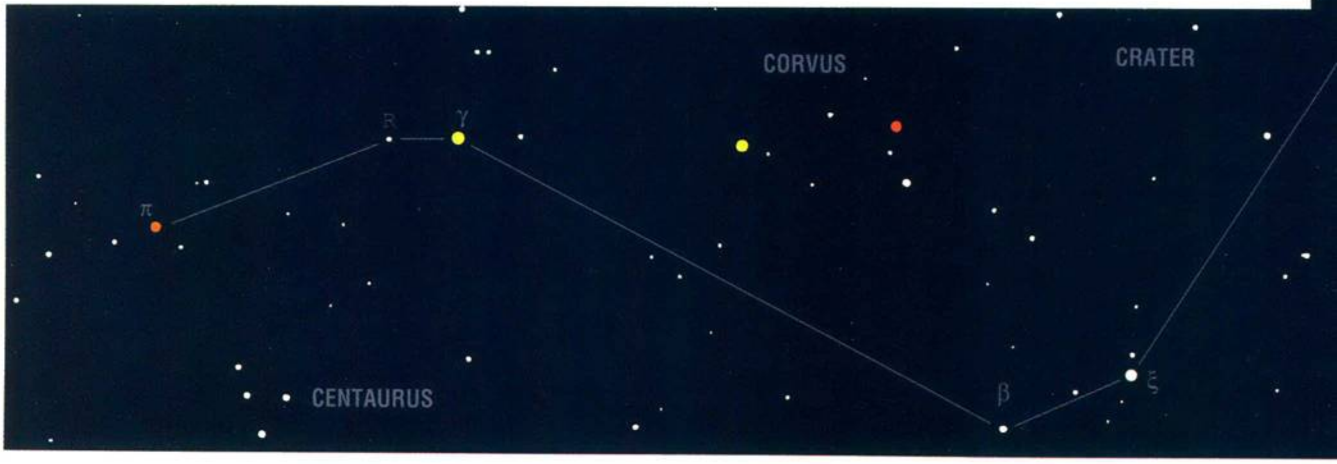
A triangle of stars represents the hindquarters of the Lion. The brightest star in the triangle is Denebola, which shines at 2nd magnitude and represents the Lion's tail. There is also a Little Lion in the sky. Leo Minor consists of a bent line of faint 4th-magnitude stars located to the north of Leo. It is one of only four constellations that does not have a star designated Alpha (α), the name usually given to a constellation's brightest star. Leo Minor is a modern constellation, introduced in 1687 by Johannes Hevelius. When Francis Baily labeled the stars 150 years later, he overlooked the constellation's brightest star and didn't assign it a Greek letter.

Look even farther east for the zodiacal constellation Virgo the Maiden. Virgo represents a maiden carrying an ear of wheat, which points to the great antiquity of the constellation. In ancient times, Virgo appeared in the sky at the time of harvest. Earth wobbles on its axis and causes the constellations visible during each season to shift. By the time the Greek mythology of the sky arose, this constellation appeared in the spring — as it does now — and Virgo became associated with fertility and planting. Painters and sculptors often depicted the season of spring as a female figure carrying flowers. Virgo is large and faint, containing mostly 3rd- and 4th-magnitude stars. Its most prominent star is 1st-magnitude Spica, whose name means "ear of wheat." Although this star is about 260 light-years away, it appears as one of the brightest stars in the sky because its surface is over four times hotter than the Sun's.

North of Virgo is elusive Coma Berenices, which represents the hair of the Egyptian queen of Ptolemy III. This constellation's stars shine mostly at 5th magnitude. From the city or suburbs, you might not see them at all. But in a dark sky Coma Berenices resembles a woman's flowing hair. Binoculars improve the view.

Coma Berenices is fascinating for its location in our sky. It marks the direction perpendicular to the Galaxy's disk, toward the north galactic pole. The stars orbit about the center of the Galaxy in a clockwise fashion, unlike the planets of the solar system, which orbit the Sun in a counterclockwise direction. Looking toward the Galaxy's north pole is like being inside a transparent globe of the Earth, gazing up and out toward earthly north.

The north galactic pole isn't a place; it's just a direction in our sky. It's a good direction to look, if you have a small telescope. Small telescopes show thousands of faint external galaxies extending throughout Coma Berenices and Virgo. People

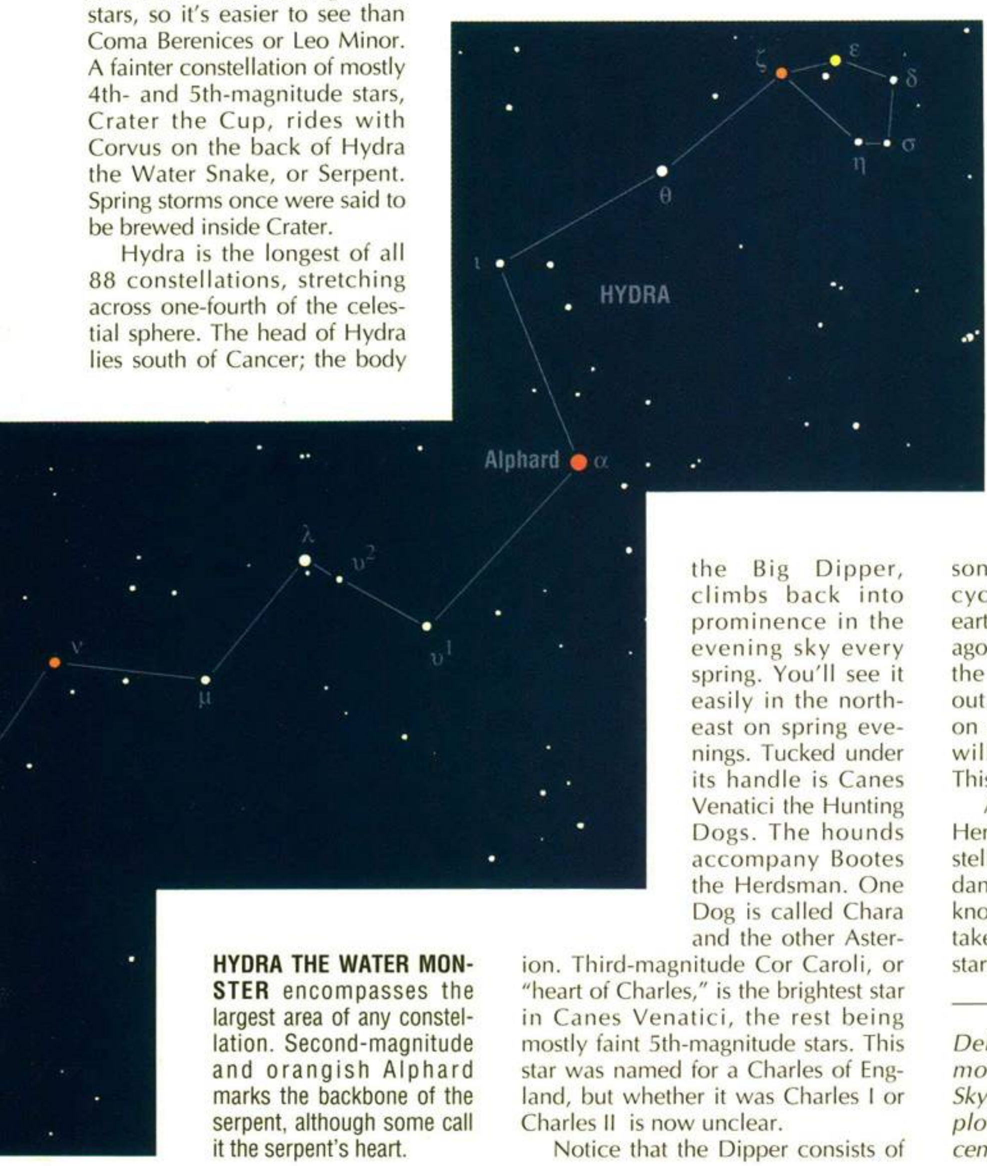


used to call this wondrous area in our sky the Realm of Galaxies, though that term seems to be falling out of use now, as powerful modern telescopes reveal more galaxies in every direction around us.

By May, Coma Berenices and the north pole of the Milky Way will be overhead in the evening. Then the disk of the Galaxy will lie nearly parallel with your horizon. If you walk toward the northeast then, you'll be walking forward in the same direction that our Sun moves around the galactic center. The Sun, like other stars in our vicinity, moves toward the constellation Hercules in the summer sky. The center of the Galaxy meanwhile will be on your right, toward the constellation Sagittarius, also in the summer sky.

South of Virgo is a lopsided square. This is Corvus the Crow, said to be the cupbearer of Apollo. The Crow contains 2nd- and 3rd-magnitude stars, so it's easier to see than Coma Berenices or Leo Minor. A fainter constellation of mostly 4th- and 5th-magnitude stars, Crater the Cup, rides with Corvus on the back of Hydra the Water Snake, or Serpent. Spring storms once were said to be brewed inside Crater.

Hydra is the longest of all 88 constellations, stretching across one-fourth of the celestial sphere. The head of Hydra lies south of Cancer; the body of the Snake lies south of Leo and Virgo. Hydra's stars take four months to cross the meridian, the line that divides the sky into an eastern and western half. In all this magnificent length, Hydra has only one bright star. Second-magnitude Alphard, the Solitary One, is as friendly looking as its name sounds. It is reddish in color and said to represent the Snake's heart. Alphard is a giant star, estimated to be 110 light-years away.



HYDRA THE WATER MONSTER encompasses the largest area of any constellation. Second-magnitude and orangish Alphard marks the backbone of the serpent, although some call it the serpent's heart.

Above the tail of Hydra is Libra the Scales. This constellation is of modern origin and substitutes for the Chelae, the Claws of Scorpius the Scorpion in the summer sky. Libra's two brightest stars, Zubenelgenubi and Zubeneschamali, form the southern and northern claws. Although these stars are only slightly brighter than 3rd magnitude, many observers list these two stars among their favorites.

The sky's most famous asterism, the Big Dipper, climbs back into prominence in the evening sky every spring. You'll see it easily in the northeast on spring evenings. Tucked under its handle is Canes Venatici the Hunting Dogs. The hounds accompany Bootes the Herdsman. One Dog is called Chara and the other Asterion. Third-magnitude Cor Caroli, or "heart of Charles," is the brightest star in Canes Venatici, the rest being mostly faint 5th-magnitude stars. This star was named for a Charles of England, but whether it was Charles I or Charles II is now unclear.

Notice that the Dipper consists of a bowl and a handle. If you extend the arc of the handle of the Dipper about 30 degrees — two to three fists at arm's length — toward the southeast, you'll arc to Arcturus, the brightest star in the constellation Bootes. Extend the line farther, and you'll drive a spike to Spica in Virgo.

Bootes represents a Herdsman chasing one of the celestial bears about the sky. Arcturus means "bear watcher." Its shape is reminiscent of a kite, with Arcturus located at the place where you'd attach a tail to the kite. This giant star appears yellow-orange and shines at magnitude −0.04. It's estimated to be located 34 light-years away.

Arcturus provides a glimpse of seasons and cycles with timescales vaster than any we experience. Most of the stars we see in the night sky are like our Sun because they lie in the disk of the Galaxy. Like fallen leaves drifting downstream, these stars all drift in the same general direction that we do through space, orbiting around the center of the Galaxy. Arcturus doesn't join in the motion of these stars. It moves around the galactic center, too, but it is cutting perpendicularly through the disk of the Galaxy. It's a member of the galactic halo, a more-or-less spherical group of stars centered on the Galaxy's center. Arcturus and the other halo stars pass up and down through the disk of the Galaxy, their orbits lasting hundreds of millions of years.

Arcturus also shows us a glimpse of other stellar seasons as it nears the end of its life cycle. The star became visible to earthly eyes only half a million years ago, as its outer layers expanded after the nuclear fuel in its core burned out. A few million years from now, on spring nights far in the future, it will have passed from view again. This is our season for seeing it.

After Arcturus and Bootes come Hercules and the other summer constellations, starting again their stately dance across the sky. Now that you know the figures and stars by name, take the opportunity as each season starts to renew your friendship. □

Deborah Byrd writes ASTRONOMY's monthly sky column "Eye on the Sky." Her last feature article was "Exploring the Winter Sky" in the December 1992 issue.

THE DIGITAL DARKROOM

"DEVELOPING" THE IMAGE

Getting the best possible results from today's incredible CCD cameras requires taking the images at the telescope and combining them later on your computer.

by Richard Berry

It's the morning after a rewarding night of astrophotography with your CCD camera. Your body is tired and your head aches. Still, you feel a strong sense of satisfaction. With your own telescope you have saved the light of a supernova, traced the outermost arms of a spiral galaxy, and captured portraits of the universe painted in billion-year-old photons. During the night you directed your energies to taking pictures; now it's time to examine the results.

You turn on your computer and anxiously check the hard drive — yes, the images are all there. A glance at your observing notebook recalls the particulars: a three-minute exposure recording a supernova in a faint galaxy, a deep exposure of the Whirlpool Galaxy, and several other images all neatly listed with their exposure times and file names.

You pour a cup of coffee. For a moment your mind drifts to years past when image processing meant doubling the time in the developing tank and printing a negative took reams of paper and gallons of smelly chemicals. Those were the days! But today it's easier; your darkroom has become a computer screen. It's time to process the night's take of images in your digital darkroom.

The Digital Negative

Since the first affordable electronic cameras came onto the market in 1989, amateur astronomers have witnessed a revolution in astrophotography. The new cameras are built around extremely sensitive light detectors called charge-coupled devices, or CCDs. The CCD detector consists of thousands of tiny light-sensitive elements called photosites arranged in a grid of rows and columns.

When you take a picture with a CCD camera, the picture is sent to your computer as a stream of numbers, with each number representing the amount of light that fell on a particular photosite. The computer displays your picture by drawing a point of light in the correct row and column on your computer monitor. Taken together, the thousands of glowing points of light accurately reproduce the image that fell on the tiny CCD chip.

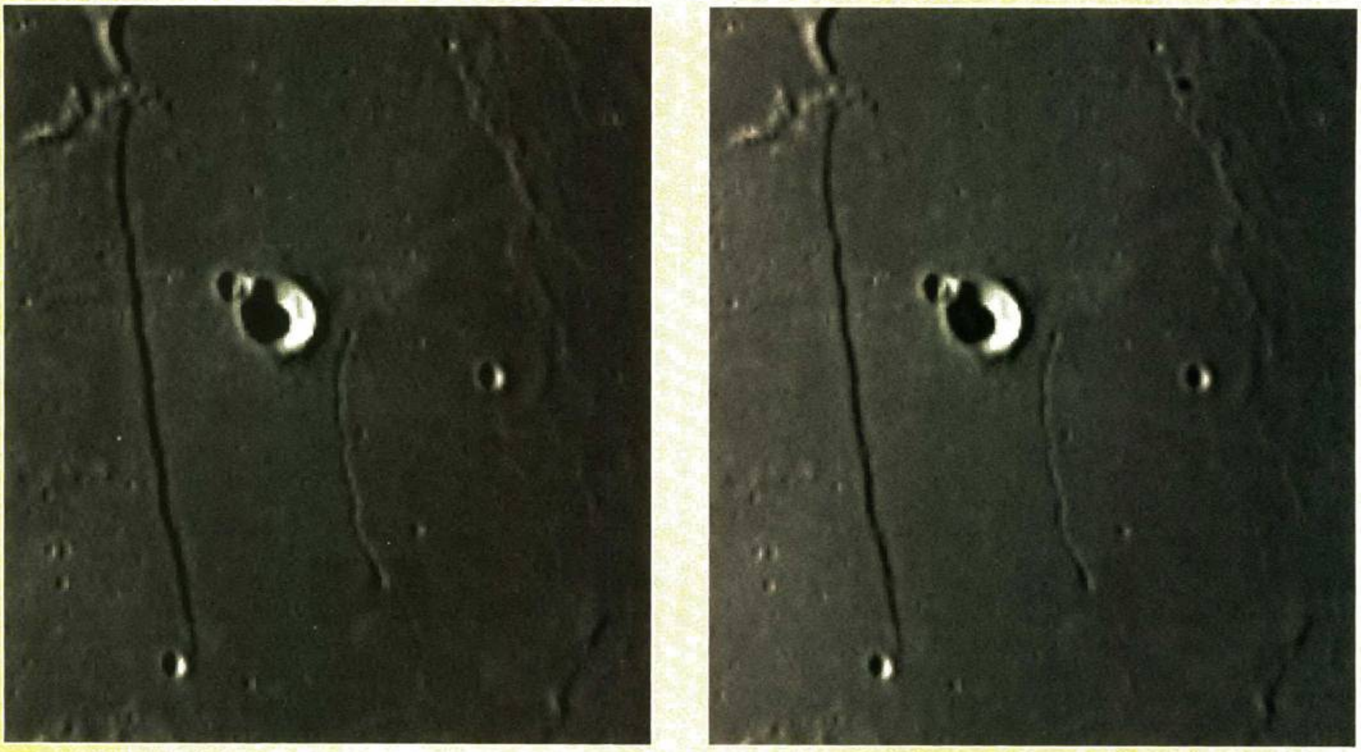
To the computer, however, an image is nothing but a pile of numbers. Changing the numbers makes the image brighter or darker, gives it contrast, or enhances fine detail that is hardly visible to the eye.

Once the image is digital — providing the numbers are perfect — it's easy to use your digital darkroom to bring the most out of an image. Performing computer enhancements such as increasing contrast or sharpening an image is

Don Parker

ASTRONOMY: Alan Dyer

SUPERB CCD IMAGES, such as Don Parker's March 2, 1992 portrait of Jupiter (far left), are possible with today's marriage of telescopes, CCD cameras, and computers.



Richard Berry

DIGITAL IMAGE PROCESSING OF CCD IMAGES WORKS BEST if you start with clean, noise-free frames. These two images of the Moon have undergone the same computer processing to enhance the images. However, the image at left first underwent a process of subtracting dark-field frames (to reduce noise) and flat fielding (to remove dust and streaks) before any further processing. Neither process was done to the image at right, so it still suffers from noise and cosmetic flaws.

the digital equivalent of printing a negative.

But as every astrophotographer knows, all the darkroom tricks in the world can't make up for a poor negative. The best print first requires a sharp, well-exposed negative. The same is true in the world of CCD cameras. The best final image starts with a sharp, noise-free "negative" — called a "calibrated" image. Acquiring such an image means extra effort at the telescope, but the resulting images will extract the best performance from your CCD camera.

Leaving the Lens Cap On

CCD cameras are capable of recording faint deep-sky objects in very short exposure times. Although exposures of only a few seconds can record a deep-sky object, the image will look noisy — similar to the appearance of a grainy negative.

In addition, CCD imaging requires that you shoot extra exposures of blank fields, something that has no parallel in conventional photography. These blank frames, called flat-field and dark frames, are a necessary part of eliminating the electronic noise inherent in all CCD cameras, even the costly models.

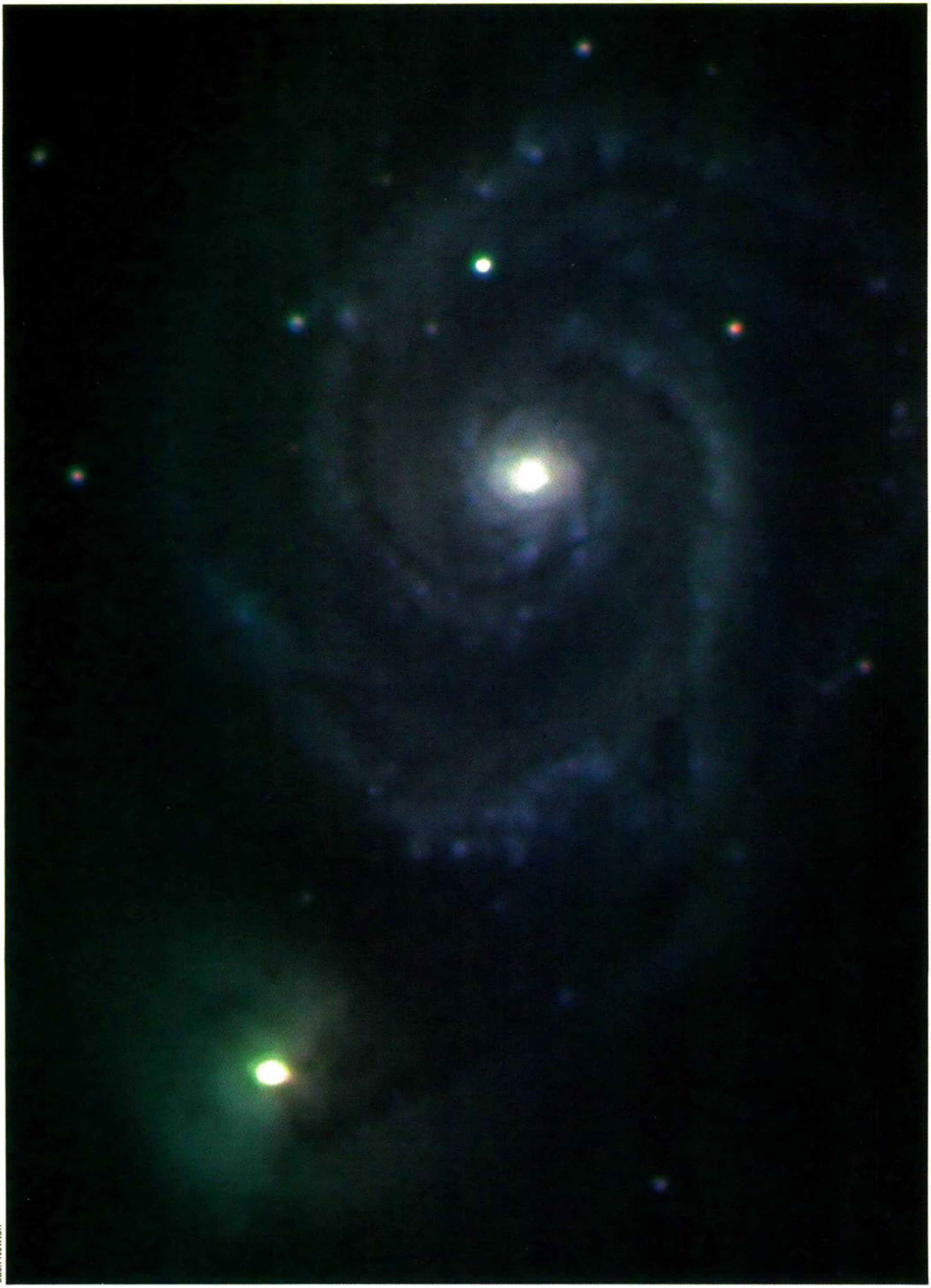
The noise in CCD cameras comes from several sources. Each causes the camera to produce slightly different readings of the amount of light falling on each photosite. For example, if you took ten identical pictures of the same celestial object and checked the brightness of a single picture element, or pixel, you might see a random variation in the brightness value like this: 993, 1012, 996, 991, 1002, 1007, 999, 985, 1013, 1002. If you average them, you'll see the values cluster around 1,000, but you know only that the brightness falls within some range of values. This random variation, called noise, is an inherent problem with CCD cameras.

CCD images are subject to four sources of noise: photon noise, thermal noise, readout noise, and quantization noise. The real strength of CCD cameras and the digital darkroom is that you can electronically subtract much of the noise in CCD images, a process difficult to do with conventional film.

Photon noise is the most fundamental of the limitations of CCD detectors. It results from the very nature of light. Light does not arrive in a steady stream, but comes in minute particles called photons. The number of photons that reach the CCD while you are making an exposure varies, just as you would expect the number of raindrops hitting a given patch of ground to vary during a rainstorm. The variation is predictable: for a large number of photons, the average noise level equals the square root of the signal level.

For example, if an average of 1,000 photons hit one photosite on your CCD chip every minute (1,000 is the signal), the actual count will vary by plus or minus 31 photons on the average (31 — the square root of 1,000 — is the noise). Sometimes the count will be higher than 1,000 and sometimes the count will be lower than 1,000, but the statistical average variation will be 31 counts. In any

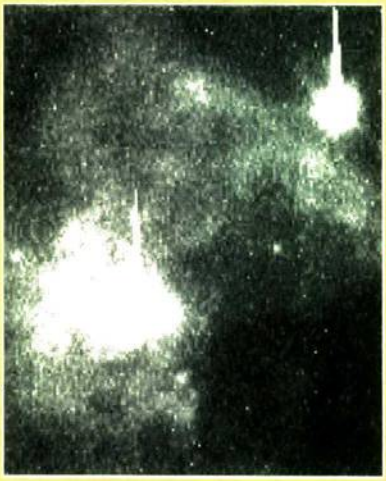
THE SPIRAL ARMS of a galaxy such as the Whirlpool are good targets for the sensitive eyes of CCD cameras. This tri-color image is a combination of three 5-minute exposures with a 25-inch f/4 reflector and an ST-6 CCD camera.



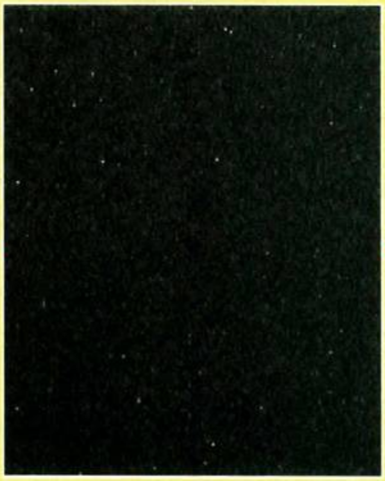
Jack Newton

Getting the Noise Out

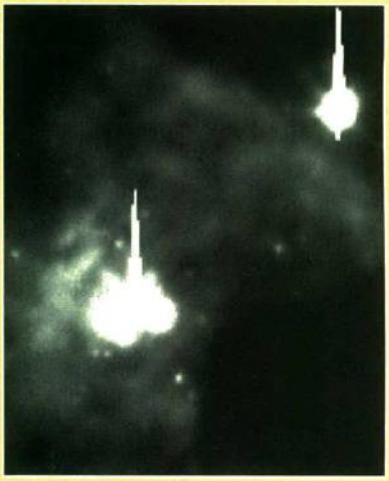
Richard Berry



A RAW FRAME, straight from the CCD camera, records an image but suffers from noise generated by the camera itself. Any further enhancements would only exaggerate this noise.



A DARK FRAME is an exposure of blackness and should be the same length as the exposure of the object. It records just the noise from the camera and is an essential part of CCD imaging.



SUBTRACTING ONE DARK FRAME from the raw image electronically removes the noise from the image, giving a much cleaner result. This is a necessary step before any other processing.

given minute, you cannot determine how many photons fell on the CCD to better than 1,000 ±31, or about 3 percent.

The cure is longer exposures. If you collect light for 10 minutes instead of 1 minute, you'll collect 10,000 photons with an average variation of 100. Although a variation of 100 is larger than a variation of 31, you now know that 10,000 ±100 photons arrived, giving an improved accuracy of 1 percent. Just as with film, longer deep-sky exposures with CCDs yield better results.

Thermal noise is the hobgoblin of CCD imaging. Thermal noise occurs because the tiny light-sensing photosites in the CCD chip generate a small signal whether light falls on them or not. The warmer the CCD, the greater the non-light signal. When you cool a CCD, thermal noise drops. CCD cameras for amateur astronomers operate around –30° Celsius, cold enough to make imaging practical but not cold enough to make thermal noise something you can ignore.

The cure is to measure the thermal noise and subtract it. Instead of making one exposure, you make two. In the first exposure, you allow light to reach the CCD chip, but in the second, you put the lens cap over the telescope. In effect, you take a picture of darkness. Such a "dark frame" exposure should be the same length as the exposure time you used for the object.

You now have two frames: one picture has light from the object plus thermal noise and the second has thermal noise only. At the computer, you subtract the dark frame from the raw image, leaving a signal that is a measurement of light only with no thermal noise, theoretically.

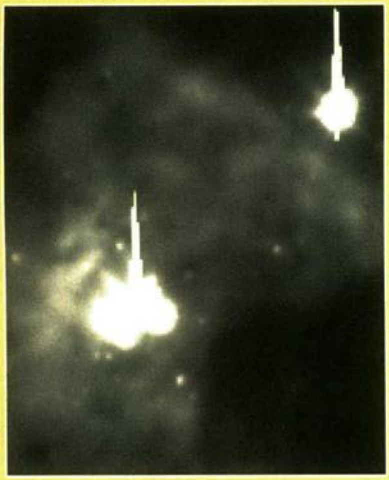
Nobody would call thermal noise a hobgoblin if its effects could be removed so easily. Unfortunately, thermal noise isn't constant. If you take a series of dark frames, each one is a bit different. To get the best possible results from a CCD camera, you need to take a series of dark frames and average them. When you subtract an averaged dark frame, you get better images than if you subtract a single dark frame.

Readout noise results from random variations in the amplifier and electronics of the CCD camera. It occurs because the amplifier cannot determine precisely how many electrons have come from each photosite on the chip as signals are read out from the CCD. Camera manufacturers specify the readout noise as the random variation in the number of electrons, for example, 80 e^- r.m.s. This means the average variation in reading the signal is 80 electrons.

Compared to the maximum signal of, say, 150,000 electrons a CCD can put out, 80 electrons is a tiny error. But if you're trying to capture very faint objects, you might be working with a signal of only 800 electrons, for which a built-in random variation of 80 electrons is significant.

The cure is a fancier camera with more sophisticated electronics, which means spending more dollars. With some of these cameras, eliminating noise requires taking two exposures with the lens cap on: a short-exposure "bias frame" that records just the amplifier noise and a long-exposure "thermal frame" that records thermal noise. In other cameras, these are combined into a single dark frame. The instruction manual will tell you the procedure for your camera.

Quantization noise is the price you pay for having digital data. When the camera digitizes the output from the CCD chip, it divides the signal into digital steps. An 8-bit camera divides the signal into 256 levels of brightness or steps, a 12-bit camera divides the signal into 4,096 steps, and a 16-bit camera divides the signal into 65,536 steps. If you have an 8-bit camera, quantization into 256 steps may be coarser than the uncertainty introduced by readout noise, thermal noise, or photon



SUBTRACTING FOUR DARK FRAMES that have been averaged together reduces noise even further. (The streaks are caused by the bright stars' overloading the CCD chip.)

Paul Boltwood

CCD CAMERAS CAN REVEAL remarkable detail, provided you eliminate the noise from the image first. This 16-minute exposure of the Crab Nebula was taken using a custom-built CCD camera on a 7-inch apochromatic refractor at f/22.

noise, so quantization noise may limit how accurately your camera can capture an image.

With 16-bit quantization, readout noise, thermal noise, and photon noise probably limit the precision of the camera, and quantization noise can be negligible. Although a 16-bit system sounds ideal, your expectation of 65,536 steps of brightness may prove false because other types of noise can limit the camera to the equivalent of 8,000 steps — still nothing to be unhappy about. With 12-bit cameras, quantization noise and the camera noise are fairly closely matched. Camera designers strive to make the quantization error smaller than other sources of noise but no smaller than necessary.

Taking Pictures of Blank Sky

There's one more bugaboo in CCD imaging: variations in sensitivity from one photosite to another on the chip. This problem sounds worse than it really is, but you can't ignore it. The sensitivity of CCDs is generally uniform to about 1 percent between neighboring photosites and uniform to about 10 percent over the surface of the chip.

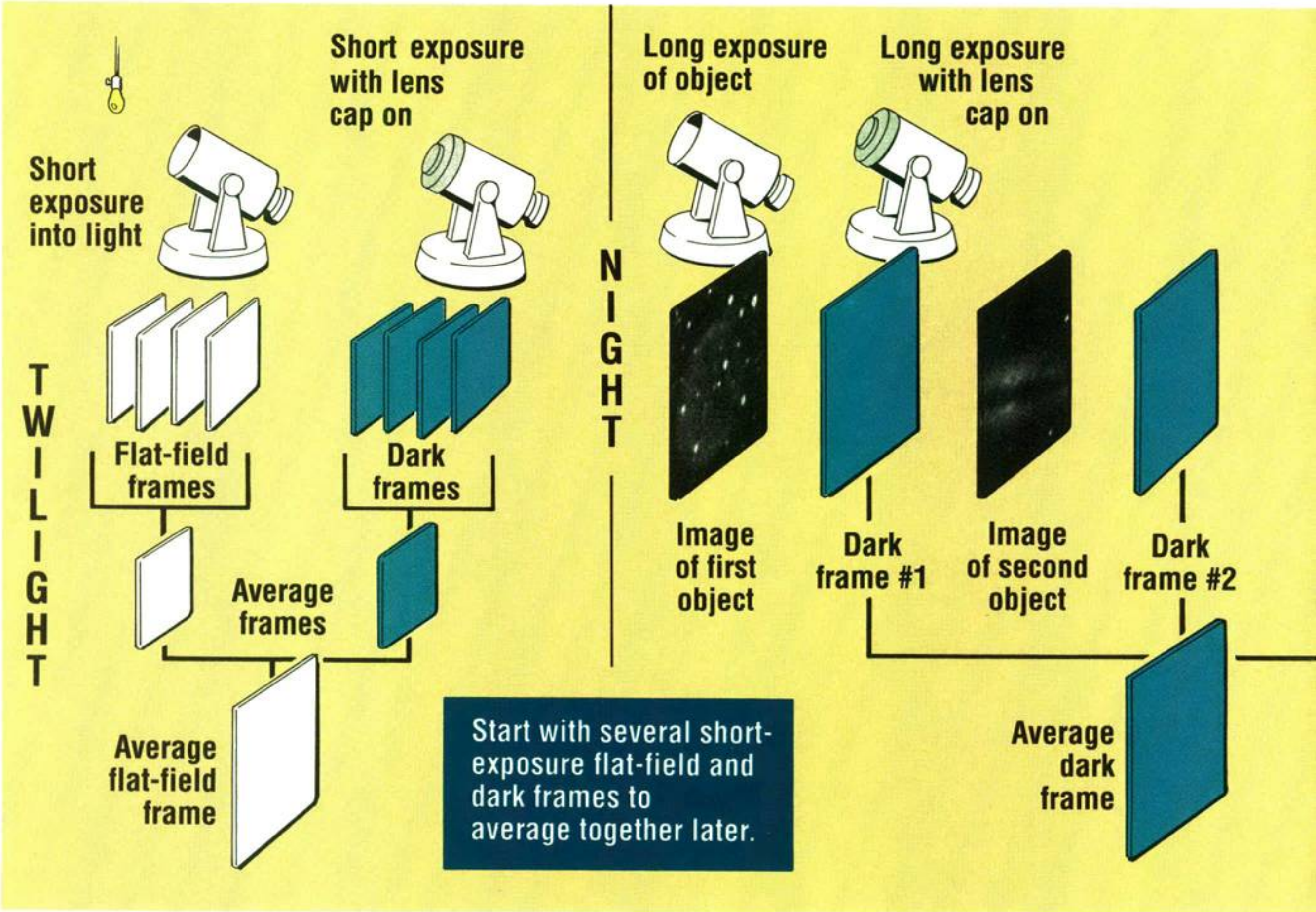
For ordinary CCD applications, such as home video cameras, the user might never be aware that there are any differences at all, but the extreme contrast enhancements used in astronomy can make slight variations in the brightness of the pixels show up as unwanted bright and dark pixels.

Again, there's a cure. As darkness falls, you shoot short exposures (1 to 2 seconds) of the uniform twilight sky. An alternative is to shoot into a diffuse light source such as a light bulb illuminating a frosted screen. When exposed to such a uniform source, all photosites on the CCD should produce exactly the same signal. But they don't.

The more sensitive photosites produce larger signals, and the less sensitive photosites smaller signals. There may be a hot spot in one area of the chip, or one side of the chip may be more sensitive than the other. Bits of dust and dirt reduce the light that reaches other pixels and can appear as dark rings.

Exposures of a uniform light source called flat-field frames map all these variations. They faithfully record the errors on the chip and every trace of shadowing or vignetting

A Night with a CCD Camera



Start with several short-exposure flat-field and dark frames to average together later.

ASTRONOMY: Lee Vande Visse

in the optical system that illuminates the chip.

The next morning when you tell your computer to "flat field" your pictures, the computer calculates the relative sensitivity of each photosite from the flat frame and applies a sensitivity correction to each pixel in your image. Photosite variations, vignetting in your telescope's optical system, and the effects of dust and dirt are swept away. Your flat-fielded image is clean and smooth. Once again, the digital darkroom performs its magic.

A Night with a CCD Camera

To see how a CCD imaging session works, let's sit in with some friends of yours, a couple who are about to begin a typical night with their CCD camera.

As darkness falls, they set up the telescope. Then they remove the camera from its storage spot in their freezer; this keeps the camera as cold as possible to keep thermal noise low. After attaching the camera to the telescope and carefully focusing it on a bright star, they start to shoot several pictures of the twilight sky. These must be flat-field frames. Now she puts the lens cap on and fires off several quick dark frames. They tell you that tomorrow they'll subtract them from the flat-field frames and then average the results to make one master flat-field frame. Gee, and you thought you just needed to take one flat-field and one dark frame.

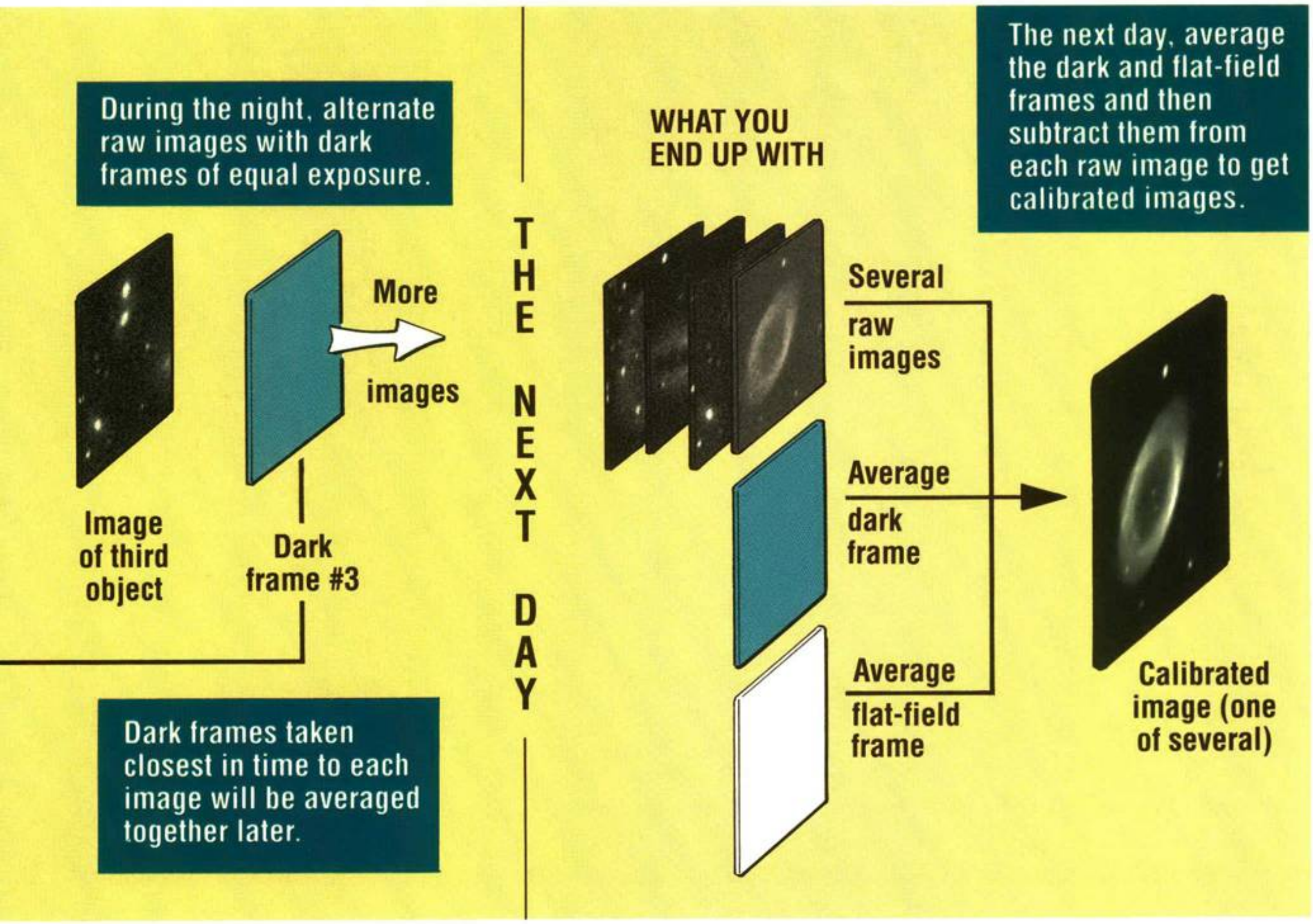
If this keeps up, your friends will accumulate a lot of images by the end of the night. Sure enough, check the computer screen . . . he's creating a new directory on their PC's hard drive just for tonight's images. Hmmm, that's a good idea. It's better not to mix tonight's images with last week's images. They also keep a logbook of every exposure. He writes them down while she takes the images. File name, time, exposure, type of image. There's a lot to keep track of.

Ah-ha! At last they're ready to take the first picture — but what's going on? As she moves the telescope over to the first target she covers the lens and takes a long exposure at the same time — a dark frame. Clever. Why waste good observing time!

Now they're on target. They refocus and take a short exposure to be sure their subject is centered in the field. Locating objects with CCD cameras is difficult because their fields of view are so small. Now they take the actual image but use rather long exposures for a CCD camera — ten minutes apiece. They're trying to avoid the salt-and-pepper graininess that comes from too few photons.

Okay, there's a picture. That's interesting — he has saved the raw image to disk without subtracting the dark frame, contrary to what some CCD camera instructions suggest. It seems they plan to do all the darkroom work when they're wide awake. Here under the stars they're only taking data. Hmmm, another dark frame.

Your friends now follow a standardized routine: They alternate raw images with dark frames of equal exposure and save every image unprocessed. They keep a record of every exposure in their notebook, and they name their files systematically. The initial flat fields are called 001FF, 002FF, and the dark frames are 003DK, 004DK, and so on. They



During the night, alternate raw images with dark frames of equal exposure.

Dark frames taken closest in time to each image will be averaged together later.

The next day, average the dark and flat-field frames and then subtract them from each raw image to get calibrated images.

name the raw images with a serial number plus the object name: 009M51 (the ninth frame of the night, an image of Messier 51), followed by dark frame 010DK, then 011M106, (a shot of Messier 106), then 012DK, and so on. Each exposure gets a number and name so it won't get mixed up with others. That's going to really help them tomorrow!

Developing the Negative

Morning brings your friends sunlight, coffee, a hard disk with dozens of image files on it, and a notebook filled with records of what each file contains. Let's watch and see what happens.

Step One: Your friends make a list of all the flat-field frames. They have eight 2-second-long flat fields and eight 2-second-long dark frames. They first average the flat-field frames and then average the corresponding dark frames. Averaging a large number of flat fields reduces thermal noise, amplifier noise, and quantization noise. They then subtract the average dark frame from the average flat-field image to produce a final "master" flat-field frame. On some nights, your friends tell you, they take flat fields at the beginning of the night and again at the end of the session to compensate for variations throughout the night.

Step Two: Your friends now make a list of the four long-exposure dark frames they took closest in time to each of the raw images of astronomical objects. They select the two taken before each image and the two after. They do this because the camera's noise can change through the night as the camera heats up or cools down.

When your friends started their CCD hobby last year, they took only one dark frame a night and used it for all the raw frames. But that gave images with lots of white and dark pixels all over the frame. Now by averaging four dark frames, they're avoiding this effect and beating the noise down further.

Step Three: Here's the payoff. She calls up each raw image, subtracts its averaged dark frame, and then flat fields by dividing the raw image by the flat-field frame. Look at what happens: each image starts out full of thermal noise that gets subtracted away. Then flat fielding cleans up vignetting, dust shadows, and the variations in photosite sensitivity. While she operates the computer, he notes each step in their notebook. Finally, she saves each calibrated image to the hard disk.

Step Four: Time to back up the night's work. He copies all calibrated images to floppy disks. They reduce a bewildering array of flat fields, dark frames, and raw images to a handful of noise-free calibrated images.

The calibrated images are like freshly developed negatives. But as with negatives, just having the calibrated images isn't enough. Negatives need to be printed. Calibrated images need image processing to bring out the details that lie hidden in the digital data. And that's a step we'll cover next month in our exploration of the digital darkroom. ☐

Richard Berry is the author of the new book Choosing and Using a CCD Camera *(Willmann-Bell, Inc., 1992) and is developing a new color-capable version of his Astronomical Image Processing program.*

ASTRONOMY SOFTWARE

NEW
VOYAGER II !! DAVID MALIN CDROM !!

CD-ROMS, IMAGES & IMAGE PROCESSING

VOYAGE TO THE PLANETS or STARS for only $134.95!! Yes, these *are* the cd-roms from ASTRONOMICAL RESEARCH NETWORK. The finest planetary and deep space images available. MAC and IBM compat image processing software included. FIT , PDS, GIF, TIF, TGA, ARN. 8/16/32 bit.

BT-ATLAS- CCD ATLAS OF DEEP SKY OBJECTS From Sky Publishing!! Over 3000 images including over 100 Messiers ....call

IMAGINE -32 32 bit image processing! Fully featured. Professional level, amature ease. A.S.A. RECOMMENDS FOR ANYONE WITH A 386, 486, or HIGHER. Supports FITS, ST4, CCD,ASC, GIF, IMQ, IMG, ARN.!retail $299.00. ASA $ 279.95. 8/16/32 bit.

DANCE OF THE PLANETS	*call*
THE SKY...all levels dos & windows	*call*
VISTA PRO....Amiga & ibm compat	*call*
EZCosmos	*$ 59.95*
VOYAGER...amiga & mac	*$109.95*
STARGAZE	*$ 94.95*
ORBITS...Voyage Through The Solar System	*$ 49.95*
SUPERSTAR	*$134.95*
DISTANT SUNS windows & amga	*call*
GENESIS PROJECT	$184.95

AND MORE !!

SHIPPING & HANDLING: U.S, $7.50.; Canada, $12.50; Foriegn, $30.00. Texas residents add 7.75% sales tax. PAYMENT: US funds only - by check drawn on U.S. bank, or money order. Foreign orders require International Postal Money Order or certified check drawn on U.S. bank.
MASTERCARD AND VISA WELCOME (ADD 2%).

ORDERS ONLY : 1-800-257-6930
ASSISTANCE : 1-512-244-6146

Send orders or inquiries to:
Astronomy Software Associates
1601 Lime Rock
Round Rock, TX 78681

Ultima binoculars from Celestron!

- Perfect for astronomy
- Fully multi-coated
- Extra lightweight design
- Carrying case included
- Limited lifetime warranty

F.C. Meichsner Co.
182 Lincoln Street, Boston MA 02111
tel:1-800-3-2-1-View!
(1-800-321-8439)

TRADE-INS • SALES • EXPERT ADVICE • REPAIRS • OUR 76TH YEAR

Many brands of binoculars and telescopes in stock
Mail orders and all major credit cards accepted

CCD IMAGING EQUIPMENT

- Imaging Systems & Accessories
- Image-Processing Computers & Software
- Automated & Manual Filter Wheels
- CCD Tri-Color, Infrared & UBVRI Filter Sets
- CD-ROM Image & Data Libraries
- FREE CCD Newsletter

MURNAGHAN
1781 Primrose Ln., W. Palm Beach, FL 33414
Phone: 407-795-2201 • FAX: 407-795-9889
Computer BBS: 704-795-0979

Increase Your Viewing Pleasure with a

VISTA BINOCULAR GUIDER

FOR 20x80mm and UNDER BINOCULARS

• Eliminates tripod hugging • Reduces arm fatigue • Views from zenith to horizon • Swivels 360°—smooth action • Three adjustable brakes • Heavy-duty construction • Weight: 7 lbs. • Tripod (optional) • $140 Visa / MC

CALL FOR FREE BROCHURE
1-800-552-9170

• In Area Code (805), call 925-1240, or write to VISTA INSTRUMENT CO., P.O. Box 1919A, Santa Maria, CA 93456.

SBIG
ASTRONOMICAL INSTRUMENTS

COLOR IMAGING IS HERE

Record and immediately display astrometric quality true color images of planets and galaxies with Model ST-6 CCD Imaging Camera

For catalog or demonstration disk contact:

SBIG
ASTRONOMICAL INSTRUMENTS

SANTA BARBARA INSTRUMENT GROUP
1482 East Valley Road, Suite #J601
Santa Barbara, CA 93108
(805) 969-1851 FAX (805) 969-0299

Color Filter Wheel assembly shown attached to Model ST-6 CCD Imaging Camera. Filter Wheel has four filter positions and a star diagonal position allowing an eyepiece to be positioned at a focus which is parfocal with the Model ST-6.

READERS OBSERVE COMET SWIFT-TUTTLE

Last autumn a lot of people were glad to see Comet Swift-Tuttle (1992t). Recovered on September 26, 1992, after 130 years by Japanese amateur Tsuruhiko Kiuchi, the parent comet of the Perseid meteors gradually brightened to naked-eye visibility. By mid-November Swift-Tuttle shone at 5th magnitude and showed its 2°-long tail in backyard telescopes.

Swift-Tuttle observing activity heated up in early November as the comet grew brighter than 6th magnitude and its tail became visible in small telescopes. On November 9, despite the Full Moon's presence, Arizona amateur Tom Polakis described Swift-Tuttle's appearance in his 13-inch scope: "I spotted a tail some 30' long using a Swan Band filter, but the tail was faint enough I had to rock the tube to see it. The coma measured 9' across and showed several levels of brightness that decreased away from the center."

The next night Polakis noted: "I rarely make magnitude estimates, but the comet is now at magnitude 5.7 in my 9x25 binoculars. I used the Hercules Cluster (M13) as a reference. Even with my sharpest eye, the two were indistinguishable in brightness."

On Friday the 13th of November Polakis noted that the comet had brightened substantially. "Through my 11x80 binoculars," says Polakis, "the tail length was an impressive 2$^1/_2$°. Based on comparing it with nearby M13, the comet shines at about magnitude 5." Viewing with his 13-inch scope, Polakis noticed that Swift-Tuttle's color appeared to be blue-green and the core resembled a 6th-magnitude "star" about 5" across. "The tail pointed to the northeast," he says, "and measured only 2' wide even though it was at least 1$^1/_2$° long. The tail made it a spectacular sight!"

On November 14 Polakis recorded "it appears the comet is beginning to develop a short dust tail to go along with its long gas tail." Polakis and some observing friends watched the comet and noticed a wider component of the tail extending about $^1/_2$° away from the coma, north of the gas tail. The long, thin gas tail was still prominent and stretched a full 2° from the coma.

Steve Coe of Glendale, Arizona, observed Swift-Tuttle with his 11x80 binoculars on November 24 and estimated its magnitude at 5.5 with a tail that stretched 2°. "In my 13-inch scope," says Coe, "the comet's coma is very bright and shows a 5"-diameter core. The tail appears exceedingly thin." Edwin Faughn of Memphis, Tennessee, observed the comet with his 13-inch scope the previous night and recorded a "division" in the tail. Mike Green of Waco, Texas, observed Swift-Tuttle on November 14 and described it as a "small, bright disk" in his 8-inch f/10 SCT at 290x. As this issue goes to press, we continue to receive reports on the comet's appearance. □

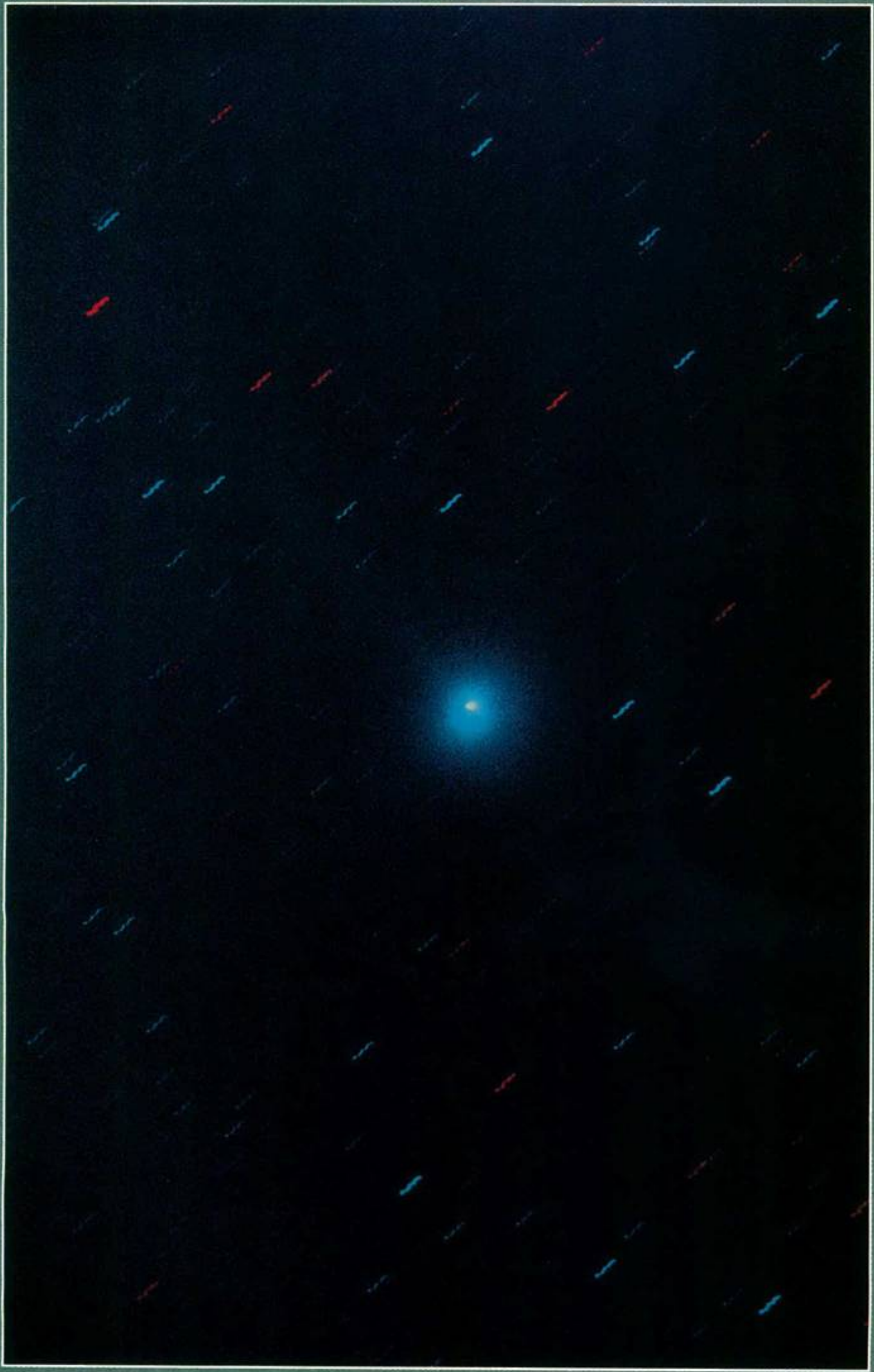
COMET SWIFT-TUTTLE glowed at magnitude 5.3 and displayed a 2°-long tail on November 14, 1992 (above). The comet blossomed into view after appearing like a 6th-magnitude elliptical galaxy just three weeks before (right). Photos by Michael Stecker.

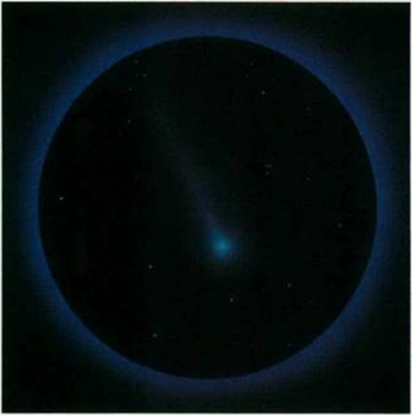
ASTRONOMY wants to hear about your observations of the sky. Please send reports, sketches, and photographs to David J. Eicher, Reader Reports Editor, ASTRONOMY, P.O. Box 1612, Waukesha, WI 53187.

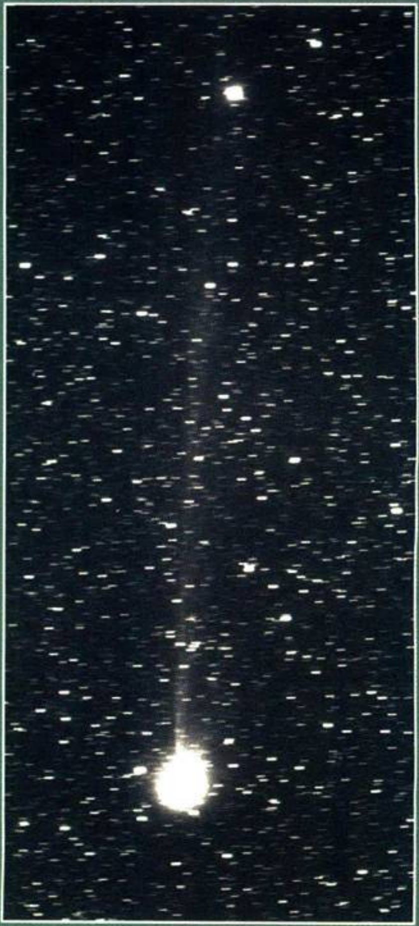
AUTUMN'S BRIGHT COMET

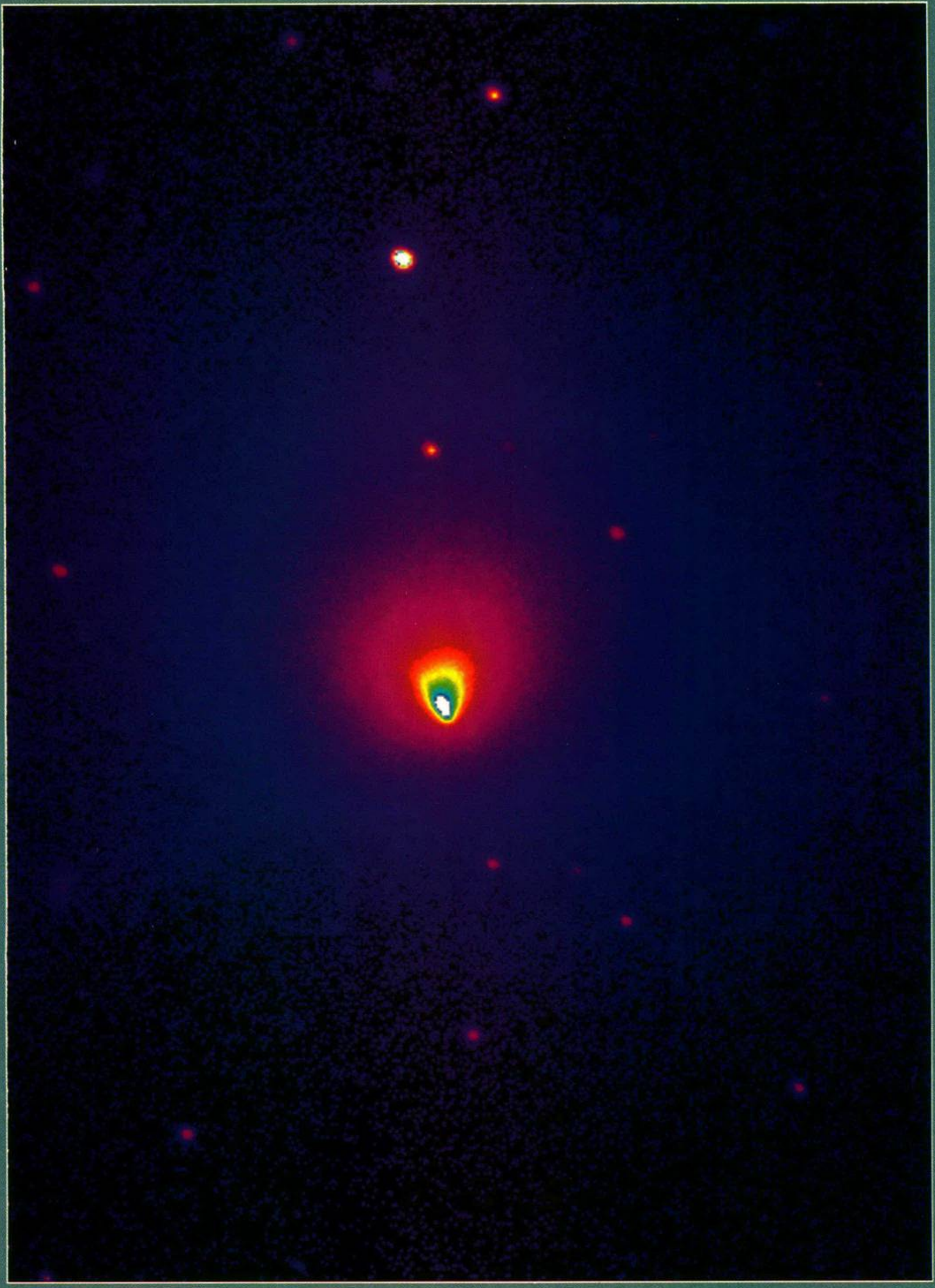
Ronald W. Kohl's CCD image of Comet Swift-Tuttle (opposite page) made on October 21, 1992, wins this month's $100 "Best Astrophoto" award. Kohl used a STAR I CCD camera and did his own image processing.

As Swift-Tuttle brightened in October and November, dozens of amateur astronomers photographed it. Ronald E. Royer's November 5 image is a two-color composite made with blue and yellow plates (below, left). Paul Roques' photo, made on November 14, shows the comet's long tail and its unusual twisted appearance (bottom right). John Chumack's photo made on October 26 (left) approximates the view through a small telescope at that time. On November 14 Edwin Faughn sketched Swift-Tuttle's tail with a 13-inch f/4.5 reflector (below).









EXPAND

your universe of customers with an ad in the "Marketplace".

ASTRONOMY delivers a big bang for your buck. You'll reach 338,000* dedicated amateur astronomers when you advertise in the "Marketplace", ASTRONOMY's new advertising section.

The "Marketplace" features an attention-getting second color to set it apart from the rest of the magazine and allow customers to quickly find your ad.

What are you waiting for? Your expanding universe of customers originates with one call.

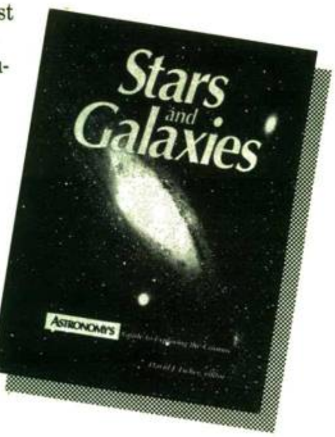
800-558-1544

Kim Bennett, Advertising Sales Manager, ext. 628.

ASTRONOMY

* Based on average paid circulation of 169,379 (June 30, 1992 ABC Audit Report) and 2 readers per copy.

Stars and Galaxies: ASTRONOMY'S Guide to Exploring the Cosmos



A lavish tour of the sky's most appealing regions that highlights 344 star clusters, nebulae, and galaxies visible in backyard telescopes. Illustrated with more than 200 photographs, many in color, charts, tables, diagrams, and eyepiece sketches. A must for every astronomer's bookshelf. Edited by David J. Eicher, associate editor of ASTRONOMY magazine. 8½ x 11, 192 pgs., 129 b&w and 110 color photos, 98 illus., hardbound.

#18536 ....$29.95

To order call toll free, 24 hours a day **800-533-6644.**

Please have your credit card ready.

Fax 414-796-0126. Outside the U.S. and Canada call 414-796-8776.

Include for postage and handling: U.S. add $3.00 4th class (or $4.50 UPS continental U.S. only); Canada add $5.00, other foreign add $10.00. Wisconsin residents add 5% sales tax to total. Canadian orders add 7% GST to total. Payable in U.S. funds. Prices and availability subject to change.

Kalmbach Publishing Co., Dept. A0728, 21027 Crossroads Circle,
P.O. Box 1612, Waukesha, WI 53187-1612

Dept. A0728

TUTHILL, YOUR ASTRONOMICAL FRIEND SAYS:

SOLAR SKREEN®

SUPER, HELICAL FOCUSING 50mm AND GIANT AMICI PRISM 80mm FINDERS

WE SELL ALL CELESTRON & MEADE TELESCOPES & ASTRONOMICAL PRODUCTS. Call us at 908-232-1786 and we can discuss your needs in detail and give you unbiased information on these and other scopes.

• • • •

Our SOLAR SKREEN® Sun filters (Pat. #3,897,140) are the only ones with internal, metallic surfaces sealed against moisture. Glass solar filters have easily-scratched exposed coatings. Our SOLAR SKREEN® assemblies now come with a FREE color-correcting filter. To see the quality of SOLAR SKREEN® results, see the picture pg. #440 in Oct. 1991 *Sky and Tel.* and pg. #686 in Nov. 1991 *Sky and Tel.* NOW UNCONDITIONALLY GUARANTEED FOR 5 YEARS.

• • • •

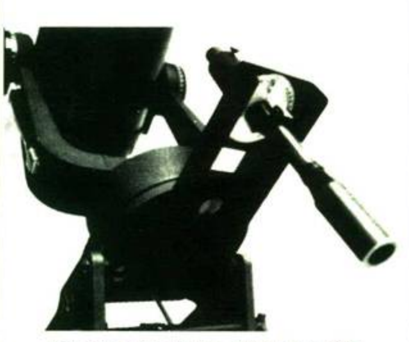
Hundreds of amateurs are still wasting time in useless attempts to accurately level their SCT tripod. Are you one of them? Forget leveling!! Use PRECISION POLAR AXIS FINDER and easily get EXACT polar alignment in minutes, making setting circles a snap to use.

• • • •

Are you wasting valuable, limited, viewing time trying to combat dewing on your SCT corrector plate? Our moisture absorbing, NO DU CAPS, which are heatable and light-weight, keep the air dry near your corrector thereby increasing your pleasure instead of your frustration.

• • • •

OUR GIANT, AMICI PRISM, CORRECT-IMAGE, 50mm & 80mm FINDERS fit any scope and easily give a correct finder view to match your sky chart view. Each FINDER has a focusable 1¼" eyepiece equipped with a rubber eyecup.



PRECISION POLAR AXIS FINDER®

NO-DU CAPS®

THESE ARE THE ONLY DEW CAPS THAT ABSORB MOISTURE

Send 9" x 12" SASE (4 stamps) for our complete information and FREE SOLAR SKREEN® sample.
908-232-1786. FAX 908-232-3804. Time payment, Check, MO, COD, Visa, & MasterCard.

• • • WE CLEAN, REPAIR, AND REFURBISH ALL SCHMIDT CASS TELESCOPES • • •

Roger Tuthill, Inc., Box 1086-A, Mountainside, NJ 07092

★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ TELRAD $38 ★ PARKS ★ BUSHNELL ★ BRANDON/VERNONSCOPE ★ SCORPIUS ★ ETC. ★ ★ ★ ★ ★ ★ ★ ★ ★ ★

IN STOCK **C 8 $888**

LOWEST GUARANTEED LISTED PRICES!

NOW YOU CAN AFFORD

ZEISS

(ONLY 12 PAIR IN STOCK)

7X50....$449 ★
10X50..$445 ★
10X50....$495 ★
WA

4 1/2" 900mm 327 $249

SEE MEADE AD

Authorized Meade Dealer

WE ARE A FULL LINE MEADE DISTRIBUTOR

SEVEN DAYS A WEEK 10 to 10

CELESTRON CELESTRON

TELESCOPES

C14 ......$5500 COMPUSTAR C14	$8999
C11 Ultima (PEC) (New Types)	$3275
CG11 ......$2849, CG Mount + Tripod	$1449
Ultima 8 (PEC) + Focus Motor	$1795
SPC 8	$885
SPC 8 w/Starbright	$1015
COMPUSTAR 8	$1799
POWERSTAR (PEC) C8+ Focus Motor	$1479
CLASSIC 8 Starbgt., Wedge, Tripod	$955
C040 Refractor Tripod (2) Eyepieces	$69
C60 ......$99 C60E	$188
Firstscope 80........$428, SPC80	$588
Refractor (SP-C102).......$880, SPC 80F (f8)	$1399
Fluorite Refractor (SP-C102F)	$1695
Telephoto 500mm F5 6	$289
C5 (AC).......$764, C5 (DC)	$924
C4 5.........$394 SPC6.......$712 C5	$624
Vixen 4 1/4" Alt Reflector	$179
Vixen 4 1/4" EQ Reflector	$289
Vixen 80mm Refractor	$435
Vixen 90mm Refractor	$348

SPOTTING SCOPES

C90 C90M/C C90 M/C Armored	$379
20x60 ......$358, 30x60	$358
20x60ED $518, C60Zoom	$318
C60R $219 C5	$624
SS80	$268
Photographic Tripod ......$94 Mini Tripod	$21
Shoulder Mount	$59

BINOCULARS

Monocular 8x25....$37, 8x25 mini....$64, 10x25	$84
Waterproof 7x50 10x50.....$195 8X56 PRO	$135
10x50 PRO...$118, 7x50 PRO...$114, 12x50 PRO	$149
Pro 9x63mm	$163
Ultima 7x42 10x42...$185, 8x32....$172 ea., 8x56	$185
Ultima 7x50 mm, 10x50mm Ultima.	$185
11x80M/C...$288, 15x80M/C...$293 20x80M/C	$297
20x100 MM GIANT, 25x100mm	ea. $849
Fixed Focus 8x40 WA 7X50WA 10x50WA	$64
ED GLASS Series 6.5X44mm 9.5x44mm	ea $394

OPTICAL TUBE ASSEMBLIES

C80 C4 5.......... $279 SPC102	$499
SPC 6	$379
8" Optical Tube Assem.	$495
C11 ......$1759 C14	$3899

ULTIMA EYEPIECES

5, 7.5 12.5, 18, 24mm 2xBARLOW (1 1/4")	ea $60
30, 42mm (1 1/4").....ea $86, 35mm	$63
45 60mm 2".....ea $158, 80mm	$236
OR 5, 6, 7, 9, 12mm (96")	ea $35
KE 10mm 16, 18 25 30 40 (96")	ea $29
Zoom 6.5-18, 1 1/4"	$105
Zoom 96" OR 8 4 21mm-DELUXE	$99

25mm K 1 1/4" Multi-Coated	$35
OR 1 1/4" 5 6 7 9 12mm	ea $45
Zoom OR 1 1/2" 8 4 21mm	$95
18 25mm 2" SPECIAL PURCHASE	ea $74
Coma Corrector Photo-Visual 1 1/4" - 2"	$173
RETICLE 6MM ILLUMINATED	$1405
Micro Guide Eyepiece	$133

T-RINGS

(State Camera Make Model) All $10 EA OR (2)	for $18
2 1/4" Format	$159

ACCESSORIES

AC Adapter (PEC)	$21
Accessory Case	$43
Barlow Lens 2x96".....$29 1 1/4"	ea $28
Barlow Lens 2x2" m/c (Giant)	ea $83
Battery (Ill Reticule) (1.5V)	$2.95
Binocular Tripod Adapter (small).....$9 (large)	$14
Car Batt. Adapter Ultima (PEC)	ea $19
Car Window Mount	$29
Carrying Case - Powerstar 8 Custom	$138
Counterweight Bar Assem -8" .... $58 11"	$64
Counterweight Set - 8" (Standard)	$48
DC Inverter (110V)	$73
Drag Erect Image - 45° 96" .... $42 45° 1 1/4"	$46
45° 96" to 1 1/4" DIAGONAL	$45
DEC Motor C8 Classic 8,	$78
DEC Motor (PEC) 8/11, Ultima-Powerstar	$78
Deluxe Lat Adjuster (DLA) C8	$30
Dewstar (Lens Shade - 8")	$23
Advanced Astro Master (ATM)	$489
Advanced Astro Master (SP /FORK)	$525
Drive Corrector - Heavy Duty	$358
Drive C8 Quartz Sing Axis (C8 - Classic)	$195
Quartz Dual Axis (C8)	$219
Expanding Bushing - 96" to 1 1/4"	$14
Filter (All Colors) 2"	ea $19
Filters #1A 8 12 15 21 23A 25 38A 47 56 58 80A 82A 96ND 50% 96ND 25% 96ND 13% Polarizing	ea $10
Filter Sets (Set of 6) .... $59 (Set of 12)	$118
Filter - Series 5 or 6 (6 ea. in Set)	$47
Filter Adapter - 96" .... $11 1 1/4"	$15
Finderscope 8x20 for C90-erect image....$54 BKT	$12
Finderscope 5x24 STG ...$29 6x30	$32
Finder Bracket (Quick Release) 8X50	$45
8x50 ....$49 16x70R/A w/pol ill	$189
R/A w/Polar Align Reticule - 8x50 Ultima w/BKT	$144
Focus Motor - C8, Classic 8, PWR STAR	$78
Focus Motor (PEC) 8/11	$78
MFFT 55	$129
Image Corrector - 1 1/4" OR .96	ea $24
Large Accessory Ring (LAR) C90	$21
Lens Shade - C90......$53 C8......$25 C11	$138
LPR Filter (Nebular #2.....$129 #3.....$42 #5	$79
#7.....$89, "A"....$49, "B"...58, C"...$75, "D" (Bin.)....	$85
Motor Drive-for C4 5 w/Dr Single Ax.-SP (DC)	ea $148

Motor Drive S A (AC) Pol/Sp	$88
Motor Drive w/Dr. Dual Axis SP (DC)	$253
Multiple Ocular Holder 96".....$47 1 1/4"	$130
Guider Body (Only)	$59
Photo Tripod Adapter 8"	$50
Photographic Tripod Deluxe Slow Motion Controls	$43
Piggyback Mount 8" $31 11 14	$54
Piggyback Mount SPC 80 SPC 102 SPC6	ea $37
Polar Axis Finder w/Illum (for C4 5)	$51
Polar Axis Finder - SPC6 - C80	$66
Polarizing Filter Set - 1 1/4"	$42
Porro Prism - 965.....	$39
Radial Guide Assy Off Axis	$109
RFA (Rich Field Adap)	$79
Refractor Accessory Ring	$18
Reducer/Corrector Lens f6 3	$125
Reducing Bushing = 1 1/4" to 96"	$16
Filter Set - Series 5 (six) .... $49 Series 6 (six)	$49
Skylight Filter Model #1 (C90s).....$31 #2 (8/11/14)	$34
Solar Filter - C90 C102 C4 5	$68
5" Off Axis - C11.....$109, C8.....$112, C60 C80	$42
Star Diagonal 1 1/4" w/Multicoatings	$38
Star Diagonal (Mirror) 2" Deluxe Adjustable (PRO)	$219
Star Diagonal 2" (Mirror)	$108
Star Diagonal 2" - Multi-Purpose	$215
Stereo Binocular Viewer	$408
Super Polaris Half Pier	$105
Super Polaris Mt & Tripod	$445
2 1/4" Camera Adapter (Specify 2 1/4" Camera)	$149
T-Adapter C90, C5, C8, C11	ea $22
T-Adapter - Refractors C4 5, C6, C60	$32
T-C 16mm Adapter $28, 6x6	$58
Table Top Mount - C65	$20
Tele Extender- Deluxe.....$38, Tele Extender	$22
TeleExtender - Refractor-Newtonian	$43
Tripod - Adjustable 8" - Armored	$219
C8 Tripod (Oak) $195 11/14	$468
VSP (Vibration Suppression Pads)	$37
Visual Back - 1 1/4" (Eyepiece holder)	$26
Wedge - C8.....$85 Heavy Duty 8".....$198 11/14	$368
Wedge UII (Heavy Duty)	$319
Tilt Plate 0 Degrees	$73

PUBLICATIONS

Owners Manuals, Acc. Catalog	ea $5
Binocular Buyers Guide Book by Alan Hale	$9.95
Sky Maps............$12 (Quantity Price)	ea $10
Star Atlas (Northern Hem.) 2000.0..$16 Planisphere	$6
Photography with your telescope	$6

MISCELLANEOUS

Lens Caps........ea $50 End Caps (SCH./CASS)	$1
f4 Reducer lens	$85
REVOLUTIONARY LANTHANUM EYEPIECES -LV SERIES - STATE OF THE ART - RARE EARTH GLASS - 2.5 mm, 4mm, 20MM, 25MM, 1 1/4"	$94
5mm, 6mm, 9mm, 10mm, 15mm.....$84, 30mm., 2"	$124

BAUSCH & LOMB

(INTERNATIONAL DEALERSHIPS AVAILABLE)
Binoculars • S. Scopes • Wholesale +
BAUSCH & LOMB ACCESSORIES

PROFESSIONAL SERIES PL OCULARS 26mm...$45 SYMMETRICAL 7/12.7/18/30mm...$33ea/6mm OR...$45/ZOOM ORTHO 8 to-21mm...$79/32mm PL...$49/50mm HASTINGS...$45/50mm RAM...$29 FILTERS SERIES 6 DROP-IN SET (6)...$49 WITH CASE/EYEPIECE ADAPTER...$28 / RFT ASSY ...$79 4X FINDER (4000)...$20 / 8X50 FINDER (8000)...$45 MEASURING RETICLE EYEPIECE...$45/TRIPOD LEGS (3)...$19/PIGGYBACK MOUNT (4")...$21/(6" & 8")...$29/ OTHERS TO B&L ADAPTER...$49/LENS CAPS - CALL/CAMERA ADAPTER 96"...$19/ F-7 5 FOCAL REDUCER #2...$39/4" ELECTRIC DRIVE BASE FORK TINES...$249 TRIPOD...$159

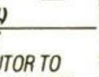
JMI

DEC MOTORS FOR MEADE CELESTRON ... $72
FOCUS MTRS FOR MEADE CELESTRON ... $75
DSC-MAX....$469 NGC MICRO-MAX . $446
NGC MINI-MAX.....$560 NGC MAX ... $749

MISCELLANY LIST (S.A.S.E. for complete list)

Adlerblick 7x50 M/C - 10x50 M/C	$269
Vogel - Digitrak Drives, Inverters-SPECIALS-	CALL
Questar Tripod H-D Field Model	$299
20" f5 PARKS ELIPTICAL	CALL
THOUSAND OAKS SOLAR FILTERS	CALL
Glass-Full aperture 8 in. MOUNTED.	$79
Astroscan - EDMUND 4 1/4" SCHMIDT/NEWTON	$287
Star Machine "Planetarium" Projector	$29

8000A 8" f10 $649 **B&L** *6000A 6" f10 $599*



Schmidt-Cass.(220V-50HZ-Avail.)

IMPORT - EXPORT

A WORLD CLASS DISTRIBUTOR TO INDUSTRY - GOVERNMENT-PRIVATE AND PUBLIC EDUCATIONAL INSTITUTIONS.

"OUR SCOPE IS WORLDWIDE"

★ ★ ★ ★ ★ ★ *OFFICIAL ★ MEADE ★ CELESTRON ★ B&L ★ AUTHORIZED DISTRIBUTORS* ★ ★ ★ ★ ★ ★ ★ ★ ★

MEADE Meade

TELESCOPES

97D.....$275, 97E....$288, 97ER Spotting Scope	$328
2045 Spotting Scope	$386
2081 Spotting scope 8" f10 .... $719 f6 3	$749
390 90mm Alt.Z. W 1.25" Eyep.	CALL
395 90mm Equit. W 1.25" EyeP	CALL
2 4" (60mm) Alt. Refracting Telescope	$89
2 4" (60m) Equatorial Refracting Telescope	$149
2.4" (60mm) Eq. Ref. w/(2) Oculars	$169
#228 2.4" Brass	$288
Refractors - LARGER SIZES	CALL
4 1/2" Reflecting Telescope Heavy Duty Mount	CALL
SN 6-6" SCH/NEWT. f4.5 O.T Assy	$449
Newt. Reflectors 6", 8", 10", 16"	CALL
2080 f 6.3 MC/OG	$1129
2080 f10 MC/OG	$1099
2060 16" f/10 SCH/CASS (Spring '93)	CALL

BINOCULARS

11x80, 20x80 M/C.....CALL, 7x42, 10x42	$179

ACCESSORIES

Equatorial Wedge plus Tripod 2045	$232
Super Wedge 10"	$389
Equatorial Wedge for Model #2080, #2045	$85
Equatorial Wedge for Model #2120	$98
Field Tripod for Model #2080, #2120	$205
Field Tripod for Model #2080(Oak) Any Color	$195
Altazimuth Adp. for Field Tripod (#2080, # 2120)	$18
Fork Mount/Drive 4".....$274 8"..... $624 10"	$724
Deluxe Latitude Adjuster 2080 or 2120	$25
Setting Circle Illuminator System #2080,	$36
#605 Magnetic Compass	$10
Azimuth Control (for Field Tripods for 2080)	$15
#603 DC Cord (25') w/cigarette plug	$16
#671 Wide-Field Adapter System (WFAS complete)	$89
Tele-Compresser Lens only (f5)	$39
Tele-Compresser System comp w/Extender Tube	$52
Eyepiece Extender Tube only	$18
Off-Axis Guider Body only	$78
Illum Ret Eyepiece Sys 1.25" 12mm...$64, 9mm	$89
Spotting Scope Adp.Plate 2120, 2080	$52
16" f4.5 Optical Tube Assy	$1195

EYEPIECES

Mod. Ach. (965) 9 12 25 40mm	$34
Mod. Achromatic 1.25" 9,12,25,40mm	$37
1.25" Orthos 4mm, 6mm, 9mm, 12.5mm M/C	$41
Sup Plossl 1 25" 6 4, 9 7, 12 4, 20, 26mm	$69
15mm	$59
32mm.....$88, 40mm, 1 25"	$135
56mm, 2"	$134
13 8mm Super Wide 1 25"	$119
18mm 1 25" ....$119, 24. 5mm 1 25"	$112
32mm 2"..........$177, 40mm 2"	$168
4.7mm 1 25".....$134, 6.7mm 1 25"	$118
8. 8mm 1 25"/2".......$138, 14mm 1 25"/2"	$172
Rotary Multiple Holder 1 1/4"	$134
Eyepiece Holder, 1 25"	$26
#915 Diagonal Prism .965 (90°)	$36
#917 Hybrid Diagonal Prism 965/1 25"	$36
#918 Diagonal Prism .965/1 25"	$36
#919 Diagonal Prism w/threaded Ring 1 25"	$40
#929 2" Diagonal Mirror including eyepiece adapter with 1 1/4" Adapter	$84
#930 Diag Mirror 2" OD Barrel for 2" Focuser Sleeve	$129
#924 Erecting Prism 1 25"	$56
#927 Erecting Prism 45° Diag.	$40
#928 Erecting Prism System 45°	$42
#912 Roof Prism 965, 908, 97D, 97E, 97ER	$49
#931 Hybrid 45° Erecting Roof Prism .96 - 1 1/4"	$49

FILTERS

Photo Vis. Color Fil. & Pol. 1 25" All Col. Avail	ea $11
Filter Sets 1 1/4" (4) #1, #2, #3, #4,	ea $42
Set of 6 Photo Visual Filters (965) Thread In	$60
Series VI Drop-In Filter Set (2045, 2080)	$46
Series V Drop-In Filter Set (908, 97D, 97E, 97ER)	$46
#905 Variable Polarizing Eyepiece System 1 25"	$48
#908 Nebula Filter 1 25" (B).....$55 (N)	$89
#910 Nebula Filter 2" (B).....$85 (N)	$119
#911 Nebula Filter (rear cell Thread on) (B)....$86 (N)	$109
#122 2X Tele-negative Amplifier (for all 8" & 10") 1 1/4"	$40
#126 1 1/4" Barlow (2045.4420)	$39
#127 2X-3X Variable Tele-negative Amplifier	$54
#131 2X Tele-negative Amplifier 965 (291, 294)	$36
#140 2X Tele-neg Amplifier (for all 8" & 10") S/C	$60

#581 Sun Shade (97)	$37
#712 Dew Shield 8" 2080....$98, #710,2120 10"	$108
#1A Skylight Filter/Dust Seal	$44
#50 Accessory Case.....$58, Case (2080)	$89
(2045S)............$44, Case (97SS)	$29
Extra 2lb Weights for 1401 or 1402	ea $20
Tube Balance 2045	$43
#1401 Tube Balance Weight System 2080	$69
#1402 Tube Balance Weight System 2120	$74
Extra Counterweight 25lb, 1"	$66
Extra Counterweight 40lb, 1 1/2"	$79
#71 Focuser 1 25" ID ......$44, #67 Focuser 1 25" ID	$57
#680-#682 Deluxe Focuser 1 25" & 2" ID	ea $84
#60, #61, #62 T-Adapters	$22
Tele-extender.......$22, Tele-extender (Variable)	$36
Basic Camera Adapter 1 25" 965"	ea $29
Variable Projection Camera Adapter 1 25"	$39
2" Prime Focus Adapter .... $39 (.96)	$20
T-Mount Camera Ring Adp'rs (Spec. Camera & Model)	$10
Piggyback Bracket 2080/2120.....$30, 2045	$16
#957 9x60 Finder Scope	$88
#967 9x60 Polar Illuminated View Finder w/bkt.	$133
#637 6X30MM View Finder + Bkt.	$39
#544, 8x50 View Finder	ea. $58
#781 Electric Motor Drive AD (323, 4420)	$79
#55 Manual Declination Cont. .....$69, #65RS	$106
48RS Dual Axis Dr. Corrector Sys.	$369
Electronic Control Center (ECC)	$222
#43 R A Drive Corrector (operates from 12VDC)	$80
#46 Dual Axis Drive....	$259
#47M DA Dr. Corrector Sys	$294
#36 Single Axis-Dual Axis Drive Corrector Control	$89
#38M Electric Declination System	$89
#39 Declination Motor for LX5, LX6, Premier	$69
#66A Manual Declination Control . $42 #66C	$54
Casters (2" Diameter) for 16" (set of 3)	$38
Leveling Screws (set of 3) for 16"..$38, for 10"	$29
#868 Extension Tube (2"-10", 16")	$20
Vinyl Dust Cover for 16".....$26, for 10"	$29
Lens Caps -96 1 1/4".....50¢ ea. ... 7	for $3
Vinyl Dust Cover pair 6" ......$26, pair 8"	$36
Accessory Shelf for 6"-8"-10".....$39, for 16"	$49

NO APD PRODUCTS EXPORTED

Accessory Shelf for Field Tripod (2045,2080,2120)	$24
#AD-1 Eyepiece Adapter 965, #AD-2 1 1/4"	ea $18
Mirrors, Eq. Mounts - Please call for quotes	

2045D	$559
CARRY CASE	$66
"SMART DRIVE" "PPEC" UNITS 30 40 46 50 56 70 76	

2080 - ALL AVAILABLE FROM.....$1095
2120 - ALL AVAILABLE FROM.... $1495
PLUS $600 ACCESSORY PACKAGE.....FREE (USA)

ALL MODELS .... CALL...

FUJINON

6X30 FMTR-SX	$348
8X30 FMTR-SX	$345
8X40BFL	$242
7x50 MT-SX....$298, 10X70 MT-SX	$389
7X50 MTRC-SX......$372 TX50 MTR-SX	$320
7X50 FMT-SX	$348
7X50 FMTR-SX	$383
7X50FMTRC-SX (WITH COMPASS)	$435
10X70 FMT-SX....$435, 16X70 FMT-SX	$539
25X150 MT.......$6125, ED	$7125
TRIPOD BKT.	$14

★ STEINER ★

MILITARY MARINE	$449
STEINER 7X50, 10X50	
B+L US NAVY 7x50	$295

MEADE EQ REFRACTOR

WITH 1 1/4" $169 OCULARS 9MM AND 25MM

OUR STOCK #300

WHOLESALE OPTICS

TELRAD W/BASE $38

WHOLESALE OPTICS

MAIL ORDERS TO:
29 KINGSWOOD ROAD
DANBURY, CT 06811
TEL: **(203) 746-3579**
FAX : *(203) 746-7572 (24 HRS)*
FAX ORDER LINE ONLY

TEL: (203) 792-0218 • PUBLIC WELCOME • NO SALES TAX •

• SHOWROOMS: 57 NORTH STREET/SUITE 401, DANBURY, CT 06810•

BUSINESS OFFICES SAT 11 to 5PM •

• PHONE ORDERS 10AM -10PM (7) DAYS A WEEK •

JCB 3% Credit Charge

Buyers Guide

Telescope Accessory Catalog/Data Pack (3lbs)...$10 refundable	
Complete pkg. (Telescopes - Spotting Scopes - Accessories -Binoculars) (4lbs)...	$15
Catalog Charge (Out of USA) .....$20 Minimum shipping Charge (via UPS).....	$5
(CT Tax for in state sales only) Minimum shipping - Foreign Orders	$19.00

KOWA
SPOTTING SCOPES

TSNI	$325
TSN2	$314
TSN3	$724
TSN4	$680
TS601	$260
TS602	$250
20X, 25, 30, 40, 60, 77 ZOOM 20-60X	$159
OTHERS	CALL

★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ THE BEST TIME TO CALL IN ORDERS: 6 TO 10PM - (WORST TIME: 10 AM TO 1 PM) ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★

WE HAVE EVERYTHING AT WHOLESALE OPTICS ★ TELEPHONE ORDER LINES 7 DAYS A WEEK ★ 10 AM TO 10 PM EST ★ (203) 792-0218 ★ (203) 746-3579

UNIVERSITY OPTICS ★ JASON ★ VOGEL/DIGITRACK ★ TECTRON ★ DAVIS & SANFORD ★ J.M.I. ★ STEINER ★ ADLERBLICK ★ 1000 OAKS ★ SWIFT ★ EDMUND ★ JENA ★ QUESTAR ★ DELTA BRAND ★ PENTAX ★ TASCO ★ VIXEN ★ LOSMANDY ★ ZEISS ★

SIMULATING GRAVITY

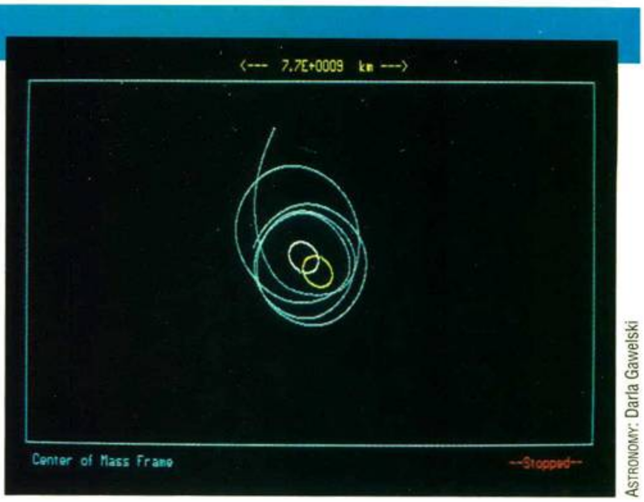
***Orbits* (1.02)**, *Physics Academic Software, a project of the American Institute of Physics; distributed by the Academic Software Library, P.O. Box 8202, North Carolina State University, Raleigh, NC 27695-8202. Phone (800) 955-8275. $59.95, plus shipping and handling. Minimum requirements: IBM PC-compatible computer, 384 KB free memory, DOS 2.1 and CGA display. Math coprocessor and EGA or VGA are highly recommended. Available on 5$^1/_4$" or 3$^1/_2$" diskettes.*

After planetarium-type programs and deep-sky object databases, gravity simulators are arguably the most popular astronomical software. They let you explore the orbits of satellites around Earth, planetary orbits around other stars or even binary star systems, and what the solar system would be like if gravity behaved differently. One of the best of these programs is Orbits.

This software will calculate the positions and velocities of up to five light bodies around one or two massive bodies. Orbits is easy-to-use and provides nine prerecorded scenarios to help you learn how to manipulate the program. These prerecorded interactions include a model of the solar system, the orbit of a space station around Earth, the motion of the so-called Trojan asteroids in their path around the Sun in Jupiter's orbit, the orbit of a planet around a binary star, and the collision of two solar systems. You can also create and save your own scenarios.

While the simulator is running, you can change the energy of an orbiting body with a simple keystroke, add thrust to an orbiting space vehicle, change time steps to watch quickly changing orbits, or zoom in on one of the bodies. You can also plot the orbits as seen from one of the massive bodies, the center of mass of the system, or from a frame of reference that rotates with the massive bodies.

This is not a demonstration program though: it's a tool for understanding the nature of orbital motion. It takes some thinking about an object's orbit to produce a new scenario, and even more thinking to understand what the plot of an orbit says about the gravitational interaction between two or more bodies. But that's the nature of the physical world and not a shortcoming of the program. Orbits excels at showing realistic and complicated orbital problems that are difficult to understand with just paper and pencil. What Kepler, Newton, Gauss, or Lagrange would have given for a program like this! — *Dave Bruning*



ASTRONOMY: Darla Gawelski

WATCH A PLANET circle a binary star with Orbits.

Choosing and Using a CCD Camera, *by Richard Berry, (Willmann-Bell, Inc., 1992), ISBN 0-943396-39-5, 96 pages, softcover, $29.95. The book includes QwikPIX software on two 5$^1/_4$" diskettes. Minimum requirements to run QwikPIX: IBM PC-compatible computer and a CGA display. A hard disk with 1.5 MB of free space and a VGA display are recommended.*

Thinking about buying a CCD camera? Or you just bought a camera but your images don't look up to snuff? Berry sweeps away the mystery of what CCD specifications mean and how to match a camera to your telescope and observing projects. Then he tells you how to get the most from your raw image by calibrating it.

Berry wrote Choosing in a straightforward way, keeping to one main idea per book spread (two facing pages). And to demonstrate the ideas behind calibrating CCD images, he includes QwikPIX, a program that will calibrate Lynxx, ST4, and Electrim camera images. QwikPIX isn't just a demo program; it will make calibrating your future CCD images easy and quick.

Choosing gets a little technical at times, talking about gamma scaling and root mean square values. But this isn't needless jargon: these are important concepts if you wish to make the most of your CCD. Berry shows you which concepts are important and how they affect your images.

My only complaint about the software is that the user-interface is not very user friendly. Using two-letter codes is archaic and gives a clunky feel to software that works well otherwise.

If you have a CCD camera or want to buy one, then you should get this book. It will help you get more from your images. The price is a bargain considering that you get both QwikPIX software and a book. — *Dave Bruning*

NEW SOFTWARE

***A Computer Canon of Lunar Eclipses* 1500 B.C. to A.D. 3000**, *Willmann-Bell, Inc., P.O. Box 35025, Richmond, VA 23235. Phone (804) 320-7016. $29.95. Minimum requirements: IBM PC-compatible computer, CGA display, 640 KB memory, and DOS 3.0. A hard disk with 3 MB of free space is recommended.*

This program provides a graphical display of the data contained in Bao-Lin Liu and Alan D. Fiala's *Canon of Lunar Eclipses 1500 B.C. to A.D. 3000*. It will show the path of the Moon during an eclipse and the locations on Earth where you can see first and last contact. You can print the maps on an Epson-compatible dot matrix printer or an HP Laserjet-compatible laser printer. Or you can save the maps to a PCX-formatted file for use with other programs. Also you can search the database of eclipses for those events that meet criteria regarding their magnitude, type of eclipse, and visibility at different locations on Earth.

Destination: Mars! Now on CD-ROM
Compu-Teach, 16541 Redmond Way, Suite 137-C, Redmond, WA 98052-4482. Phone (800) 448-3224. $59.95. Minimum requirements: IBM PC-compatible computer, VGA 256-color display, 2 MB memory, and a CD-ROM drive. The program supports Sound Blaster, AdLib, Sound Master, and other sound cards.

Destination: Mars! is an interactive game that focuses on an imaginary trip to Mars. Users launch a spacecraft, dock with a space station, rescue satellites, and visit the Red Planet. In addition to the program software (reviewed in AstroBytes, February 1992), the CD-ROM includes sound effects, NASA film footage, and 64 minutes of recorded audio. □

LOSANGELES
OPTICAL CO

Telescopes, binoculars and accessories are our *only* business.

We feature a large showroom display of better-quality, major-brand instruments and accessories from such established, nationally-known vendors as: **MEADE Instruments, Celestron, Bausch & Lomb, Bushnell, Edmund, TeleVue, Lumicon, Fujinon, Zeiss, Swarovski, Bogen, etc.**

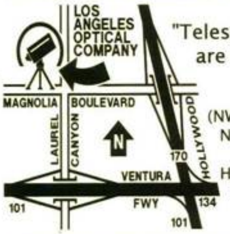
Enormous selection of astronomy books, maps and charts.

Astronomy software and databases from such vendors as: **ARC Science Simulations Software, Software Bisque, Farpoint Research, CompuScope, Future Trends Software, Sky Publishing, etc.**

Knowledgeable, friendly, helpful, non-commissioned staff. Everyday low discount prices.

Authorized Meade Dealer Meade

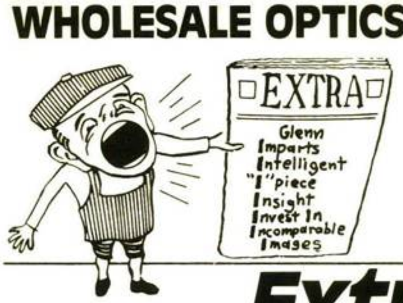
LOSANGELESOPTICALCO



"Telescopes & Binoculars are our *only* business"

12129 Magnolia Blvd
(NW corner, @ Laurel Cyn)
N. Hollywood, CA 91607
818-762-2206
Hours: 10-5:30, Mon-Sat
Free Off-Street Parking
M/C - VISA - D/C

WHOLESALE OPTICS OF PENNSYLVANIA



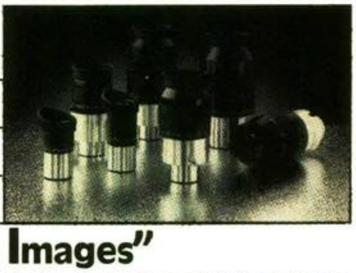
For All Your Astronomical Needs

We're TeleVue Specialists

TELE VUE EYEPIECES AT MIDWINTER SPECIAL PRICES!

Extra! Extra!

Glenn
Imparts
Intelligent
"I" piece
Insight ...



"Invest In Incomparable Images"

Start the New Year off right with the right choice of eyepieces. TeleVue's Plossl, Widefield, Nagler and Panoptic's deliver the most value for your money. You've invested a lot in your telescope, now let its' images pop with sharpness and contrast. Al Nagler's designs have less astigmatism and lateral color while delivering the largest area of sharp stars across the largest apparent fields available. In addition, TeleVue inspects every single eyepiece (makes our job easier) because their reputation is based on total customer satisfaction. After all, TeleVue wasn't awarded U.S. and Japanese patents for simply re-hashing what was already on the market. Remember, an investment in quality eyepieces can and will last you for a lifetime of viewing. Contact Glenn today for the right eyepiece at the right price!

Wholesale Optics of Pennsylvania
North Pocono Village Shopping Center, RR 6, Box 6329, Moscow, PA 18444
Call till 9 PM: (717) 842-1500 FAX (717) 842-1408 24 hrs. Showroom Hours 10-5

P. List – send SASE with .58¢ in stamps
3% Cr. Cg.

Cat. $5.00 (within U.S.)
$8.00 to Canada
$10.00 Elsewhere
$5.00 MIN SHIPPING UPS (IN U.S.)

JMI *The Revolution Continues...*
Bringing World-Class Technology to You!

NGT-18 Next Generation Telescope $10,000

18" f/4.5 Equatorial Newtonian, astrophotography-ready. Delivery one to four weeks. Made in the USA.

JMI
Industry First Video Catalog

1993 Revised Video

Space does not permit us to show all of our products, so **we will *pay* you to order our video!**

Order our revised video catalog for $10 and we will give you $20 in gift certificates - use them like cash toward your next JMI purchase. Call 1-800-452-0281 or 303-231-6136 (operators at this number cannot answer technical questions). Overseas add $10 for Airmail (VHS - NTSC or PAL).

Jim's Mobile Incorporated
810 Quail Street Unit E • Lakewood, CO 80215 • USA
Orders: 800-247-0304 Orders/Info: 303-233-5353
FAX: 303-233-5359

Overseas orders/inquiries welcome. VISA/MC/M.O./Check. S93C3

NEW! 8" f/3.48 Maksutov-Newtonian $2,750

Incredible views and astrophotographs are possible with this new, high-quality telescope. Perfect for CCD imaging too. Does not include mount - adapters available for C-11, G-11, and Tele Vue Systems mounts. Delivery one to four weeks. Made in the USA by JMI - optics from Russia.

Zero image shift focuser

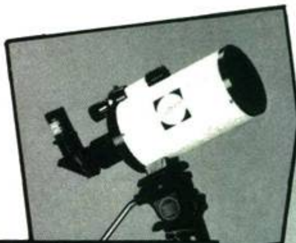
JMI
NTT
Industry First Video Catalog

NTT-25 New Technology Telescope $22,500

25" f/5.0 Computer-driven Alt/Az. **NTT-25C** model available with computer correction for field rotation, "GOTO" slewing mode, and your choice of Tele Vue Panoptic™ eyepiece - add $2,400. Delivery six months. Made in the USA.

SCOPE CITY ARRIVES IN PHOENIX

Visit Scope City, the world's largest and most complete telescope, binocular and microscope *discount* centers.



For the most competitive legitimate prices in the industry, call our mail order department or request a complete catalog package ($7). Refundable with purchase.

SCOPE CITY / MAIL ORDER DEPT.
P. O. Box 440, Simi Valley, CA 93065
CA (805) 522-6701 (order & info.)
Nat'l (800) 235-3344 (orders only)
Fax: (805) 582-0292

BUY • SELL • TRADE • SERVICE

Scope City

IN PHOENIX, AZ
20 E. Camelback Rd. (at Central) **(602) 263-0075**

SCOPE CITY LOCATIONS

SIMI VALLEY, CA
679 Easy St.
(805) 522-6646

SHERMAN OAKS, CA
14324 Ventura Blvd.
(818) 789-5805

COSTA MESA, CA
3033 S. Bristol
(714) 957-6900

TORRANCE, CA
3132 Pac. Coast Hwy.
(310) 326-3251

RIVERSIDE, CA
10076 Magnolia Ave.
(909) 359-5591

LAS VEGAS, NV
2216 Paradise Rd.
(702) 733-9288

SAN DIEGO, CA
4766 Clairemont Mesa Blvd.
(619) 277-6686

SURPLUS STORE-SIMI VALLEY
679 Easy Street
(805) 522-6646

Precision Solar Filters

Thousand Oaks Optical solar filters are recognized around the world for their quality, consistent density and even coating across the entire aperture. We specialize in solar filters only and are the largest solar filter manufacturer in the world. Filters are available to fit all brands of telescopes and binoculars. **Thousands of our filters are in use around the world. The preferred choice of telescope dealers and exclusively used by NASA aboard the Space Shuttle.**

GLASS - *TYPE 1* *(Full Aperture)*

Made from high quality hand select glass, machine polished and TRIPLE COATED with a Nickel-Chromium alloy (same as Inconel). Mounted in a machined aluminum cell ready to attach to telescope. Solar image is yellow-orange. No secondary filtering is necessary.

Aperture	Mounted	Aperture	Unmounted
2.4"	$49.00	2.4"	$39.00
3.1"	52.00	3.1"	42.00
3.5" to 4"	59.00	3.5 to 4"	49.00
4-1/4" to 5"	74.00	4-1/4" to 5"	64.00
6"	79.00	6"	69.00
8"	95.00	8"	85.00
10"	109.00	10"	99.00
11"	119.00	11"	109.00
12.5" to 13.1"	149.00	12.5" to 13.1"	129.00
14"	169.00	14"	149.00

40mm to 80mm Binoculars - Mounted .... $92.00 pr.

GLASS - *TYPE 3* *(Full Aperture)*

Coated to a neutral density of 4 for serious astrophotographers who desire the shortest possible shutter speeds with slow films. Solar image and optical quality same as type 1 & type 2. Type 3 filters are for photographic use only.

Aperture	Mounted	Aperture	Unmounted
2.4"	$79.00	2.4"	$65.00
3.1"	82.00	3.1"	69.00
3.5" to 4"	99.00	3.5 to 4"	79.00
4-1/4" to 5"	125.00	4-1/4" to 5"	110.00
6"	135.00	6"	115.00
8"	159.00	8"	139.00
10"	172.00	10"	152.00
11"	199.00	11"	179.00
12.5" to 13.1"	229.00	12.5" to 13.1"	209.00
14"	259.00	14"	239.00

GLASS - *TYPE 2* *(Full Aperture)*

Same as type 1, except stainless steel is combined in the coating to provide an even more durable surface that highly resists wear due to excessive handling and ultraviolet radiation. Solar image is also yellow-orange.

Aperture	Mounted	Aperture	Unmounted
2.4"	$62.00	2.4"	$52.00
3.1"	65.00	3.1"	55.00
3.5" to 4"	76.00	3.5 to 4"	66.00
4-1/4" to 5"	96.00	4-1/4" to 5"	86.00
6"	105.00	6"	95.00
8"	125.00	8"	109.00
10"	139.00	10"	119.00
11"	149.00	11"	139.00
12.5" to 13.1"	179.00	12.5" to 13.1"	159.00
14"	199.00	14"	179.00

40mm to 80mm Binoculars - Mounted .... $115.00 pr.

Threaded camera filters also available.

Types 1 & 2 are for unlimited visual use and general photographic use. Instructions included with all filters, including tips on solar photography.

Our filters are many times more durable than common aluminized Mylar. Aluminized plastic cannot hold up to long-term ultraviolet radiation and environmental contaminants as well as Nickel-chrome and stainless steel coated glass. Wrinkled Mylar can cause visual and photographic difficulties, can be easily damaged in handling or if placed on an uneven surface, and is difficult to clean. Also, a light blue solar image does not yield as much detail and contrast.

H-alpha prominence filters now available.
Priced from $675-$785 complete & ready to attach to telescope. Includes free Type 2 white light filter.
Please call or write for additional information.

SOLAR ECLIPSE VIEWERS

Mylar

Aluminized on both sides. Mounted in rigid frame. Mylar window: 1-5/8" x 3-1/8". Each filter supplied in individual envelope. Light transmission is blue.
3" x 5" Overall size .... $1.00 ea.

Plastic

Same as Mylar except this filter yields a sharper image with orange transmission
2-5/8" x 4-5/8" Overall size .... $2.00 ea.
Minimum order of 10 eclipse filters in any combination. Please add appropriate shipping/handling. 10 units: $3.00. Plus $1.00 for each additional 10 units. Minimum credit card order of $25.00. Quantity discounts available starting at 100.

Mylar and plastic viewers are coated to a neutral density of 5. Transmission in visual light is approximately 1/1,000th of one percent. There is no significant transmission in ultraviolet or infrared. Designed for naked eye visual use.

Ordering Information:

Solar filters are shipped free in continental U.S. when payment is included with order. Shipping extra on credit card orders ($3-$6 depending on aperture). Payment may be made by personal check, bank check or money order. We also accept **Visa, MasterCard** and **American Express. PLEASE SPECIFY TELESCOPE BRAND AND/OR OUTSIDE DIAMETER MEASUREMENT OF TELESCOPE TUBE.** The cost of the filter is based on the telescope aperture. The mounting cell fits over and around the end of the telescope tube (friction fit). The coating faces the inside. Unmounted filters are the glass only.

Free brochure available.

Foreign inquiries: Please include $1 for return airmail postage of brochure. Proforma invoices available upon request.

30 DAY UNCONDITIONAL MONEY-BACK GUARANTEE

THOUSAND OAKS OPTICAL

Box 5044-289 Dept. A
Thousand Oaks, CA 91359
Phone: (805) 491-3642 Fax: (805) 491-2393

✦ Zephyr's ✦

Astronomy Software

High Quality Software! Great Prices!

☐ **AstroCalc**™ - Input time/date & your lat/long and get for Sun, Moon, & all planets: Right Ascen/Dec, Alt/Azm, Ecliptic Lat/Long, Angular Size, Fraction Illum., Elongation, Orbital Elements, Rise/Set Times, Brightness, Distances from Sun & Earth. Also provided are: Local Sidereal Time, Greenwich Sidereal Time, Solar Equation of Time, Twilight Start/End. Heliocentric & geocentric data. Users manual. Thousands of satisfied users. IBM, Apple II, C64 **$29.95**

☐ **AstroCalc Plus**™ - All features of AstroCalc basic version plus: Automatic repetitive calculations (solar/planetary positions or any other data for every hour or day, etc.). Output as ASCII file for use in wordprocessor, etc. or printed output. Visual displays with RA/DEC views, Alt/Azm. views, heliocen. or geocen. overhead views. Configuration file saves your location, time zone, etc. IBM **$59.95**

☐ **AstroCalc Super**™ - All features of AstroCalc Plus version and: High resolution plots of Sun, Moon and planets in CGA,EGA or VGA modes. Output on screen or to laser or dot matrix printers. Get heliocentric and geocentric plots of longitude & distance or latitude and distance, RA & DEC, and altitude and azimuth. Multi-color plotting. Plots can be continuous lines or distinct points. Save selective output configuration files. IBM,CGA/EGA/VGA **$89.95**

☐ **AstroCalc Pro**™ Features of Super version plus: Use 16 automatic search modes. Find when Sun, Moon or any planet is in a specified part of the sky. Find angular separations in the sky. Get dates & times on-screen, printer, disk file. Other searches: longitudes, latitudes or distances, rise/set times, angular size, phase, elongations, brightness. Easily find events in past, present, future. IBM **$129.95**

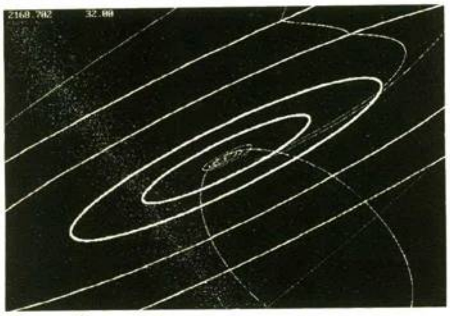
☐ **SunTimes**™ Generates monthly or yearly sunrise and sunset tables for any year and for any location on Earth. Get output to screen or printer. Also calculates the times of twilight(civil, nautical and astronomical) the maximum altitude of the sun and the hours of sunshine for each day. Accurate, easy to use. IBM. **$29.95**

☐ **MoonTimes**™ Similar to SunTimes but gives data for the Moon. Includes rise/set times, phase of the moon and the azimuth (or horizon position) for each rise and set time. IBM. **$29.95**

☐ **TrakSat**™ Follow Earth satellites in their orbits & predict where & when to observe them. Includes database of over 500 of the most important satellites, plus add more using standard NASA data. Gives ground tracks on a world map, plus 3-D views of Earth from space and satellites orbiting it. Get satellites plotted against star maps to plan observing sessions, and more!
IBM Herc/CGA/EGA/VGA **$89.95**

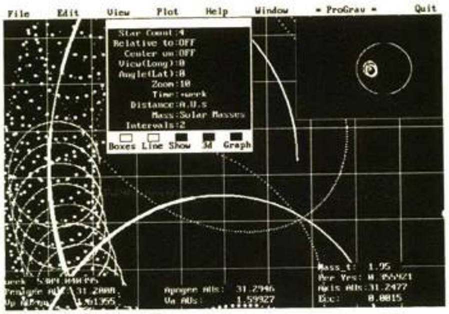
☐ **NiteMapper**™ - For any date & time generates on-screen world map showing day area in white, night area dark, & flashing symbols where Sun & Moon are directly overhead. Also shown are equator, moon rise/set line & ecliptic, lunar nodes & perigee point projected onto surface. Update information in real time, keep a fixed time, or advance conditions one hour in time every few minutes. Date & time on screen. For planning observations or educational.
IBM CGA monochrome, Apple II, C64/128 **$29.95**
PLUS Version 16 color EGA/VGA with alt/az & ecliptic plots **$49.95**

☐ **StarPilot**™ Pilot your personal starship through the universe! Explore our own Solar System & its planets & satellites as well as 6 imaginary star systems with planets. Hundreds of different bodies & over 50 space stations & ground bases to explore! High quality, accurate visual & flight simulation developed by professor of astronautical engineering. Fire up your engines, ease out of the docking station & head out to the Moon, orbit Saturn, land on Mars, use hyperspace to go to Novimir, Arboria, Asgard,... & other distant horizons! IBM CGA/EGA/VGA **$59.95**



☐ **Howington Orrery**™ Includes Sun, and all 9 planets displayed on screen in the correct positions for any date chosen. Halley's comet included and the Voyager I & Voyager II space probes. User's manual guides you on a tour of the solar system. See the launch of the Voyagers and the encounter of Voyager II with Neptune. Check out Halley's comet at the Sun in 1986 or look ahead to 2062. Speed of the display updates can be set from slow (1.5 hours) to fast (5.5 years). Press keys 1 to 9 to identify each of the 9 planets on the screen. Draw the orbit of each planet or track each planet's movement with a trail on screen. PageUp/PageDn keys increase or decrease the field of view. Home and End Keys take you to Earth's orbit or to Pluto's orbit. Set time to run backwards to replay an event or to see the solar system in the distant past. This fascinating program is a source of information and fun. IBM & compatibles, Hercules,CGA,EGA,VGA **$39.95**

☐ Have an original, high quality program to publish? Please write for our Programmer's Guidelines.



```
Star Count:4
Relative to:OFF
Center on:OFF
View(Long):0
Angle(Lat):0
Zoom:10
Time:week
Distance:A.U.s
Mass:Solar Masses
Intervals:2
```

```
Apogee AUs:  31.2946
Va AUs:       1.59927
Mass_t:  1.95
Axis AUs:31.2477
Ecc:     0.0015
```

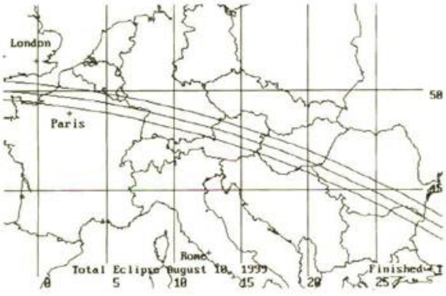
☐ **Gravitator Pro**™ - Adds these features beyond Plus: 2nd view window allows seeing system from another scale or orientation. Binary orbital pairs can be added by inputing orbital elements. Orbit objects can be added to existing bodies. Optional 3D plotting uses red/green images & supplied 3D glasses for depth effects. Plot radial velocities of any two bodies. Track orbit function follows 2 bodies & shows closest approach, distance& velocity, perihelion, eccentricity & more. Save and recall screen images as PCX graphic files, use in other programs. Prints portrait or landscape, scale laser images. IBM EGA/VGA. Dot matrix or laser printers. **$149.95**

☐ **Gravitator Plus**™ - Adds these features beyond Gravitator: Uses pull-down menus and mouse(optional) for easier operations. With EGA /VGA uses 16 color mode; you can assign colors to bodies. Grid system allows better evaluation of systems. Display distances between bodies and the forces between pairs of bodies. System can be fixed to a specified body for easier tracking, more.
IBM Her./CGA/EGA/VGA. Dot matrix or laser printers. **$89.95**

☐ **Gravitator**™ - Calculates gravitational forces on astronomical bodies such as stars & planets & determines their orbits. See paths plotted & vary scale of view, orientation & angle of view. Input any set of initial conditions, use examples provided or get random sets of clusters. Save systems created to run later or try new conditions. Vary time factor to speed up or slow down simulation. Manual explains theory & use. IBM, monochrome CGA or Hercules graphics **$39.95**

☐ **Personal Observing Log**™ A database of the 1160 most important deep-sky objects. Locate, research & keep records of your observations. Add or edit objects. Add detailed info, up to 16 pages per object! Use filters to get objects. Get rise/transit/set times. 31 customizable reports, output to screen, printer or file. Get map number of each object for four main atlases, Sky 2000, Uranometria, Norton & Peterson. Access the full NGC catalog of 7840 objects to find fainter objects. IBM and compat. **$79.95**

☐ **NightSky**™ For observation planning or reference get a wide variety of charts & data. Star charts with Sun, Moon, planets & deep-sky objects at variable scales, output to screen or dot-matrix. Some comets also included. Magnitude filter for stars. Center charts on a constellation. Color with EGA/VGA. Data includes RA & Dec, rise/set times, magnitude, more for Sun, Moon, planets. Simulation of Jupiter's moons. Input Lat & Long, dates 1 AD to 4000AD. IBM Herc/CGA/EGA/VGA with 19,000 stars **$79.95**, with 50,000 stars **$99.95**



☐ **SunTracker Plus**™ All features of the regular SunTracker and: Hi-res, 16 color EGA/VGA modes. Width of totality path is visible on screen by plotting the bounds of totality = 100%. Eclipse paths plot in black for total eclipses; annular paths in white. Bounding lines are red, oceans blue and land areas are green. Accepts as input the Saros number, a numbering convention for 18 year intervals between similar eclipses. Use Saros numbers to watch a series of eclipses. A Saros series table for 5729 BC to 6627 AD is included. Screen includes path summary table, date of the eclipse and Saros numbers. Above illustration is Super version. Plus uses full world maps(various orientations)IBM EGA,VGA. **$49.95**

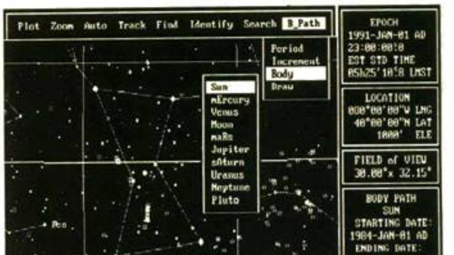
SUPER version Plots eclipse paths on variable scale maps in color. You give center of map & overall size in long./lat. Add titles, cities,etc. Plus version included in Super version. IBM EGA/VGA. **$89.95**

Regular version does calculations and basic B&W world map plots and data of central line, duration, etc. IBM CGA, Apple II, C64 **$29.95**

☐ **Astronomy Lab**™ Learn astronomy with your computer. As 70 page manual text explains a topic simulate it on screen. Functions include: 6 sky views, 12 graphical charts, 12 event reports. Explains solar and lunar eclipses, transits of Venus and Mercury, occultations of stars, Jupiter & its moons, seasons & equinoxes, calendar,more. IBM, harddisk or 3.5" floppy. EGA/VGA **$59.95**

☐ **GalaxCrash**™ Simulate the collisions of galaxies on screen. Computer calculates the gravitational forces on the stars so that they move in accordance with Newton's laws of motion to show the typical results of colliding galaxies: whirlpools, rings, bridges and other structures. You specify the number of stars in the first galaxy & the mass, location and the velocity of the second, galaxy. IBM CGA graphics **$29.95**

PLUS Version Uses 16 color EGA or VGA graphics, assign colors, scale view, get PCX file output and more. IBM EGA/VGA **$49.95**



```
EPOCH
1991-JAN-01 AD
23:00:00:0
EST STD TIME
05h25'10.8 LMST

LOCATION
000°00'00"W LNG
40°00'00"N LAT
1000'  ELE

FIELD of VIEW
30.00°x 32.15°

BODY PATH
SUN
STARTING DATE:
1984-JAN-01 AD
ENDING DATE:
1984-JAN-01 AD
INCREMENT:
0001d00h00'00"
```

```
Partial Solar Eclipse
Magnitude: 0.170  Obscuration:  0.3%
LAST CONTACT
```

☐ **LodeStar Plus**™ All features of 2.1 version and these additions: High resolution 16 colors with EGA/VGA modes. Includes all 7840 NGC galaxies, clusters, nebulae, etc. Options to plot RA&Dec grids and constellation boundaries. Automatically search for and see solar and lunar eclipses, planetary conjunctions, occultations. Plot the paths of Sun, Moon & planets on sky view. Video mode lets you record screens to display later for reference or demonstrations. Calculates parallax, nutation and aberration and ephemeris time corrections for high accuracy. Supports any of 300 printers, dot, laser or jet. Sophisticated interface including pull-down menus and mouse support to easily access all 78 functions. IBM & compat. Hercules, CGA/EGA/VGA. Works with or w/o co-processor. **$149.95**

☐ **LodeStar Plus II** Added features include: Add your own objects in a user database. Assign names to user objects and create detailed images of objects(examples included). Find bright stars, constellations and user objects by name. Optional SAO star database includes 259,075 stars (all stars down to mag. 11.9) for more detailed sky views and charts (needs 8.5 meg hard disk space). Uses more custom assembly language routines for faster operation. **$199.95**
With 259,075 star SAO database **$229.95**

☐ **LodeStar**™ **2.1**- Get accurate, variable size views of the sky for any date & time from 9999BC to 9999AD for any location on Earth. Includes over 9,000 stars(all naked eye and some to mag. 7.8), Messier objects & Sun, Moon & all planets. Investigate past, present and future with LodeStar! Choose any size view from 180 deg. to 0.18 deg., with or w/o constellation lines. Set limiting mag., option for colored stars & size proportional to magnitude. Sun, Moon & planets show actual size & phase at high magnifications. See solar eclipses, planetary conjunctions, occultations, transits, etc. Scroll to any object to recenter display or zoom in or out. Use target to identify stars or objects & get RA/Dec, Alt/Az, Rise/Set & transit times. Calculates refraction, precession, parallax.

- ✦ Automatic tracking and plotting at solar, lunar or sidereal rate
- ✦ Simulates daytime, twilight or night sky for date, time, location
- ✦ Image can be normal or reversed as in telescope eyepiece
- ✦ Star Data: HD#, Flamsteed #, Constel., magnitude, color
- ✦ Sun, Moon & Planets: Geocen. lat. & long., ang. size, phase

IBM or compat., 384K, CGA. Works w/ or w/o co-processor. **$89.95**

☐ **AstroInfo**™ High accuracy data for the Sun, Moon and all planets. Most results accurate to seconds of arc. Select any date from 999BC to 4000AD and any latitude and longitude. Provides position in sky, brightness, rise/set times, & much more. Do searches for conjunctions of Sun, Moon & planets (specify separation), distances from Earth, and locations in the sky(specify RA & Dec boundaries). Generates ephemeris tables to screen, printer, ASCII files. IBM **$49.95**

☐ **AstroStell**™ - Teaches you all 88 constellations plus deep sky objects. Includes: Call constellations by name to screen, Random display to guess names, & magnitudes of bright stars, Deep sky objects(galaxies, star clusters, nebula, double stars), Classical lore. Input date/time, & get constellations visible. History of constellations & star charts. Observing tips & using a telescope. IBM, Apple II **$29.95**

Plus Version Graphical display for more realistic views. Stars connected by lines to form constellation shapes. Colors with EGA/VGA. More about stars & constellations. IBM CGA/EGA/VGA **$49.95**

MasterCard

Plus 112 More Excellent Programs!

Order Today!

VISA

☎ 1-800-533-6666

24 Hrs 7 Days a Week **FAX Orders to 412-422-9930**
For Info or in PA Call 412-422-6600

By phone or mail. Check, M.O., credit card(#&expir.). Add $4 shipping($6 overseas). PA add 6%. Give computer type. Add $1/prog. for 3.5"IBM. Join tens of thousands of satisfied customers in 50 states & over 100 countries. Fast air mail shipment! Call or Write Today.

Zephyr Services

The Leading Astronomy Software Publisher

ZS

1900 Murray Ave. Dept. B
Pittsburgh, PA 15217
FREE Catalog-Call or Write

Our 11th Year

HIGH PERFORMANCE AFFORDABLE
ASTRONOMY SOFTWARE

- Planetarium Simulations
- Ephemeris Generators
- Astronomical Databases
- Celestial Mechanics
- High Resolution Images
- Image Processing
- Satellite Tracking
- Graphic Animations
- Many other Astronomy & Scientific Categories

WORLDS LARGEST SELECTION OF AFFORDABLE ASTRONOMY & SCIENTIFIC SOFTWARE

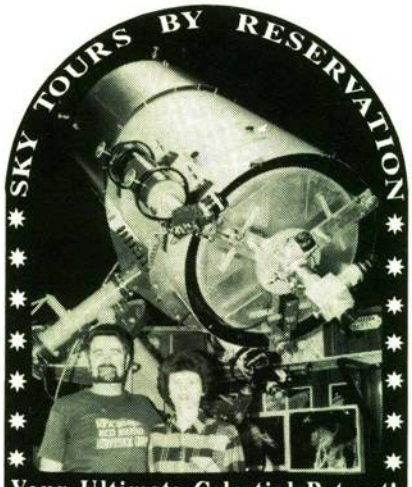
FREE Catalog - Specify IBM or Commodore 64/128
- VISA & Mastercard accepted -

ANDROMEDA SOFTWARE, INC.
P.O. BOX 605-R, AMHERST, NY 14226-0605
FAX: 716-691-6731

Astronomy software for the
Macintosh
FULL COLOR ANIMATED GRAPHICS

- Jupiter and satellites
- Saturn, rings, and satellites
- Solar System: orbits of 9 planets and 260 asteroids
- Julian Day, Universal Time, and Sidereal Time clock displays
- Full-screen calendar display of any month from 4713 BC to 9999 AD, Gregorian or Julian

FOR FREE CATALOG & PRICES, WRITE:
Jim Fremont
6646 Alcove Ave.
North Hollywood, CA 91606-1109
or call 1-818-760-8178



Your Ultimate Celestial Retreat!
BFO is located in the heart of the best vacation area on planet earth.
Lodging & Dining Facilities Available
Imagine observing through a 30" telescope at an elevation of 7500 ft. where the skies are dark & nature encompasses the entire universe.
BLACK FOREST OBSERVATORY
Department AS92
12815 Porcupine Lane
Colorado Springs, CO 80908
1-719-495-3828
A Nonprofit Educational Corporation
Call or Write for Reservation Information

OBSERVING HANDBOOKS

Observer's Handbook 1993, edited by Roy L. Bishop, (Royal Astronomical Society of Canada, 136 Dupont Street, Toronto, ON M5R 1V2, Canada, 1992), 236 pages, softcover, $14.95; $16 in Canada.

If you observe the night sky regularly and haven't heard of the *Observer's Handbook,* get a copy and peruse it — often. It contains one of the most useful collections of tables for backyard astronomers. The heart of the annual publication, "The Sky Month by Month," lists sky events and the positions and brightnesses of the planets and Moon. It also shows the configuration of Jupiter's four largest satellites.

The myriad tables for 1993 include Sun rise and set times, Moon rise and set times, lunar and solar eclipses, occultations, Jupiter satellite eclipses and transits, configurations of Saturn's satellites, asteroid positions, meteor showers, and comets. The *Handbook* also includes some tables that don't change much from year to year, but are handy to have at the telescope. These include double stars, variable stars, star clusters, nebulae, galaxies, the Messier Catalogue, the finest NGC objects, and deep-sky challenge objects.

This book contains much more than tables alone. Figures show the named features of Jupiter's atmosphere and the designations for Saturn's rings. Pronunciation guides help with the Latin and Arabic star and constellation names. Text and figures describe the forms of aurorae and link them to solar activity. The book also contains maps of the Moon and of the night sky.

The annual *Observer's Handbook* is the single most useful book for naked-eye, binocular, and telescope observers. If you don't have one, get one soon. — *Dave Bruning*

Stars and Planets, by Joachim Ekrutt, (Barron's Educational Series, Inc., 1992), ISBN 0-8120-4776-1, 159 pages, paperback, $11.95.

Stars and Planets is a pocket guide (roughly $5\frac{1}{2}$" by $8\frac{1}{2}$") for naked-eye astronomers. About half the book contains sky maps provided by Wil Tirion. For each month, two maps show the sky, one for an observer facing north and the other for an observer facing south. Considerable overlap at the edges lets you identify constellations in the east and west. A short narrative accompanies the maps, describing the constellations and recurring sky events visible that month. These maps take up so much space because Ekrutt and Tirion provide three sets: one for observers at 40 to 60 degrees north latitude, one for observers at 20 to 40 degrees north latitude, and another for observers at 10 to 30 degrees south latitude.

Other chapters explain how to use the maps, describe some astronomical objects, and list solar and lunar eclipses and significant celestial events through the year 2000. Ekrutt even makes use of the inside covers, showing solar and lunar eclipse paths.

Solar System

Satellites of the Outer Planets, by David A. Rothery, (Oxford University Press, 1992), ISBN 0-19-854289-5, 208 pages, hardcover, $75; ISBN 0-19-854290-9, softcover, $35.

Rothery casts a geologist's eye at the major satellites of Jupiter, Saturn, Uranus, and Neptune as photographed by the Voyager spacecraft. Although he avoids a lot of jargon, the text is still rather technical, appealing to advanced amateur or professional astronomers. Three categories divide the satellites: dead worlds, recently active worlds, and active worlds. An appendix lists the conventions for naming the features on the satellites. *Satellites of the Outer Planets* contains many black-and-white photos and line drawings and eight color plates.

Other Books Received

Frontiers of Stellar Evolution, edited by David L. Lambert, (Astronomical Society of the Pacific, 1991), ISBN 0-937707-39-2, 626 pages, hardcover, $44.50. Seventeen review papers from a meeting discussing the formation and evolution of stars.

The Space Distribution of Quasars, edited by David Crampton, (Astronomical Society of the Pacific, 1991), ISBN 0-937707-40-6, 401 pages, hardcover, $44.50. Proceedings from a technical symposium on optical surveys of quasars and the clustering of quasars in space.

Quantitative Astronomy, by Thomas L. Swihart, (Prentice-Hall, Inc., 1992), ISBN 0-13-747445-8, 289 pages, hardcover, $46. College astrophysics text using calculus. □

Tired of poor service and know-nothing clerks?

Call *astronomics* instead.

Authorized Meade Dealer

Last year we sold more telescopes and more accessories to more people than in any other year in our history.

In a generally slow economy, why was 1992 our best year ever – *by a full 20%?* Probably the best reason is because of the way we treat our customers – as friends, instead of just another chance to make a quick buck.

Some other reasons? We answer questions accurately. We give honest and unbiased advice and recommendations, based on our own hands-on experience. We ship promptly from a large inventory (we don't take your money and use it for two months before even ordering your scope from the manufacturer). And we truly do care that you get the right product at a fair price – the product that best suits your needs and your budget.

A final reason is the Meade Advanced Products. They've been selling like hotcakes for months now. But we figured they'd be best-sellers. That's why we've placed orders virtually every week for the past 15 months . . . to keep a constant flow of scopes coming in ahead of the crunch – and ahead of the competition.

If your present dealer can't supply a Meade APD telescope or accessory immediately, call us toll-free at (800) 422-7876. If it's available from Meade, there's a good chance we have it in stock and can ship it to you today. Even if we can't ship today, it's a toll-free call, so it won't cost you a penny to find out.

We stock Meade, Celestron, INTES, Edmund, TeleVue, Questar, and more!

And we stock hundreds of accessories from Lumicon, JMI, Vernonscope, Telrad, Dover, Sky Publishing, Astromedia, and more. Call (405) 364-0858 for your free copy of our catalog 93AST that covers the dozens of telescope models we keep in stock. We'll include our eight-page brochure on how to pick the right scope, plus your discount prices on the scopes and accessories we carry. It's yours for only the cost of a one minute phone call. It will be the best one minute phone call you'll ever invest in astronomy.

Customer Quote of the Month #12

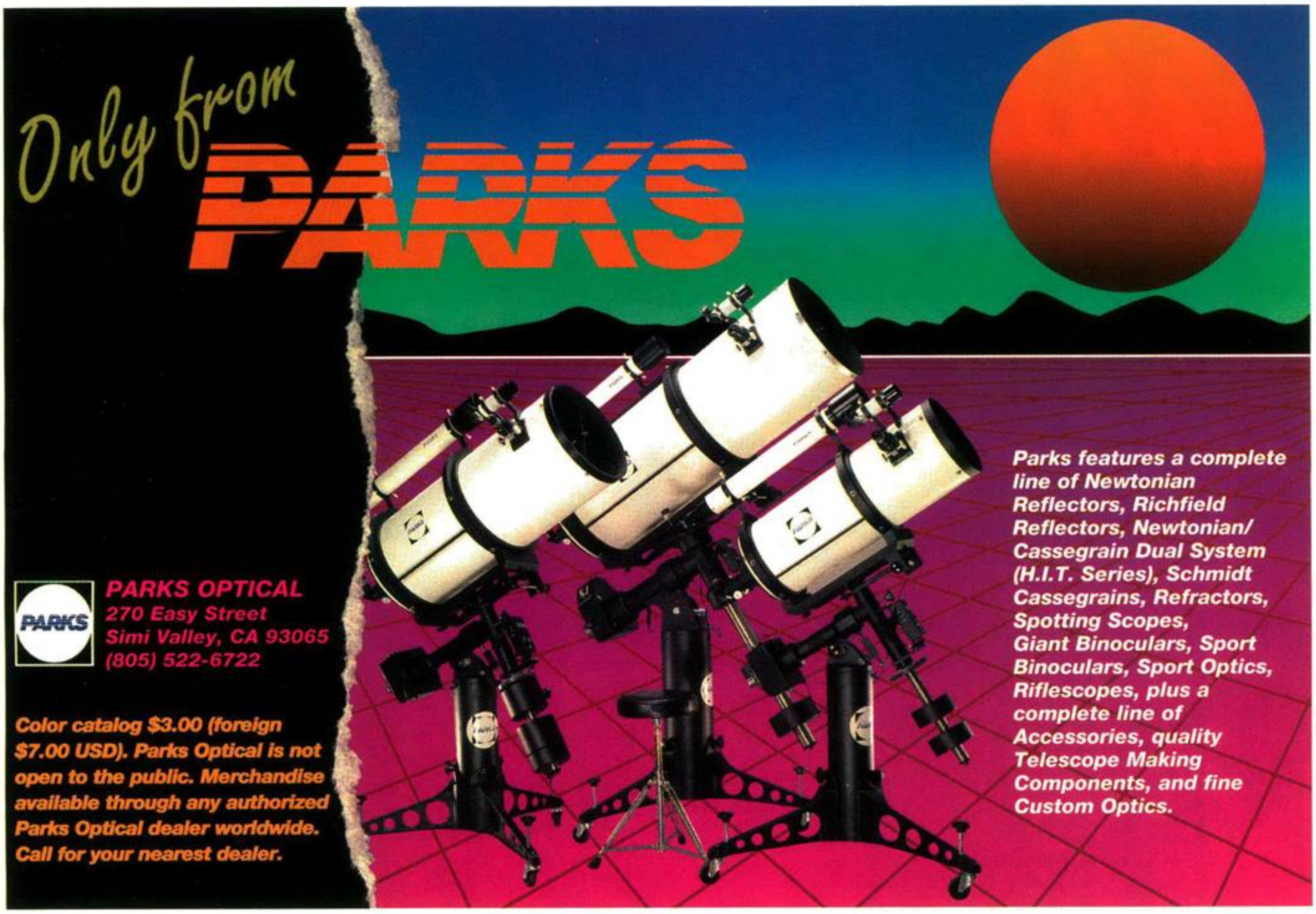
Thanks for the great amount of information you sent on scopes. You know how to treat a customer! Keep up the good work. I will recommend you.

astronomics *Our 14th year of friendly service, good advice, and money-saving prices.*

2401 Tee Circle, Suites 105/106, Norman, OK 73069

Order Line: **(800) 422-7876** Catalogs/Questions/Advice: **(405) 364-0858**

Hours: Monday thru Friday, 10:00 AM to 5:00 PM CST. Mastercard, Visa, Discover, Optima, American Express (3% handling on credit card orders).



PARKS OPTICAL
270 Easy Street
Simi Valley, CA 93065
(805) 522-6722

Color catalog $3.00 (foreign $7.00 USD). Parks Optical is not open to the public. Merchandise available through any authorized Parks Optical dealer worldwide. Call for your nearest dealer.

Parks features a complete line of Newtonian Reflectors, Richfield Reflectors, Newtonian/Cassegrain Dual System (H.I.T. Series), Schmidt Cassegrains, Refractors, Spotting Scopes, Giant Binoculars, Sport Binoculars, Sport Optics, Riflescopes, plus a complete line of Accessories, quality Telescope Making Components, and fine Custom Optics.

MEADE'S ONLY AUTHORIZED EAST COAST APD MAIL-ORDER DEALER

focus camera & video

FREE!
MILLER PLANISPHERE WITH EVERY SCOPE ORDER
While Supplies Last

FOR ORDERS ONLY CALL **800 221-0828**

INFORMATION HOTLINE **(718) 436-6262**

Meade Advanced Products

LX100 and LX200 SCHMIDT-CASSEGRAINS

LX200

IN STOCK FOR SAME DAY SHIPPING

LX200 SERIES

The new LX200 series offers, for the very first time, an easy to use, affordable, fully computerised slewing telescope. For "painless" observation simply align the telescope (using the LX200 computer) and enter any of the 747 objects contained in its' built-in library and the LX200's PPEC Smart Drive will automatically slew to that object at an increadible 8° per second. To take great astronomical photos just add the optional equatorial wedge for accurate polar axis tracking.

LX200 8"	**$2195**	**LX200** 10"	**$2495**
Wedge (8")	**110**	Superwedge (10")	**395**

Additional Object Library - adds 8000 CNGC objects to the LX200's built-in computer library **99**

YOUR CHOICE F/6.3 OR F/10 SCT OPTICS

LX100 SERIES

Meade optical tube assembly with SMC super multicoatings, heavy duty fork arm equatorial. Smart Drive PPEC RA motor drive w/ ECC hand controller for drive correction at 2x speed and image centering at a fast 32x speed.

Factory Package Includes;
F/6.3 or F/10 optical tube, ECC, 6x30 (8") or 8x50 (10") finder, 26mm eyepiece, 1¼" diagonal, AC adapter, DC car-cord, AA batt. pack, field tripod, wedge (8"), Superwedge (10") and foam fitted carrying case.

LX100 8"	**$1795**
LX100 10" w/superwedge	**$2595**

SSC SCOPES

SSC-8 8" f/6.3 & f/10	**$1395**
SSC-10 10" f/6.3 & f/10	**$1695**
SSC-12 12" f/10	**CALL**
SSC-14 14" f/10	**CALL**

STANDARD SERIES SCHMIDT-CASSEGRAINS

2045D *"The truly portable scope"*	**$599**
Case for 2045D	**75.50**
Tripod & Wedge	**234.50**
2080A *"Perfect for the beginner"*	**$1099**
2080B with SMC multicoatings	**1149**
2120A *"The best value 10" SCT"*	**$1379**
2120B with SMC multicoatings	**1449**

ED APOCHROMATIC REFRACTORS

102ED 4 Inch F/9 ***IN STOCK***	**$1995**		
127ED 5 Inch F/9	**2495**	**152ED** 6 Inch F/9	**CALL**
#1664 Electronic Drive System	**$295**		
#1697 Computer Drive System	**$595**		

STARFINDER NEWTONIANS

The new Starfinder telescopes represent the best value in Newtonians available today.

Each Starfinder telescope features Meade's hand figured optics, a precision equatorial mount with integrated motor drive, setting circles & stand.

STARFINDER 6 6" F/8	**$569.95**
STARFINDER 8 8" F/6	**$649.95**
STARFINDER 10 10" F/4.5	**$759.95**
STARFINDER 16 16" F/4.5	**CALL**

STARFINDER ACCESSORIES

Dust cover for Starfinder 6/8/10	**29.95**
#55 Manual Declination Control	**79.95**
#43 Drive Corrector runs scope on 12v DC	**88.50**
#47M Dual-Axis Drive Corrector	**299.95**

MEADE REFRACTORS

289S	**129.95**
224	**106.95**
390 90mm Altazim. Refractor	**CALL**
395 90mm Equatorial Refractor	**CALL**

PREMIER SERIES

PREMIER SERIES

All Complete Factory Packs	**2080** *8 Inch*	**2120** *10 Inch*
36 F/6.3 ***SPECIAL***	**1269.95**	--
40 SD F/10 **Smart Drive**	--	**1848.95**
56 F/6.3 ***SPECIAL***	**1698.95**	**1599.95**
50 F10	**1699.95**	**1810.95**
50 SD F/10 **Smart Drive**	--	**1999.95**
56 SD F/6.3 **Smart Drive**	**1938.95**	**1999.95**
70 SD F/10	--	**2899.95**

Super Wedge option for 2120 Premiers			**395**
2080 50 SD F10 Smart Drive Factory PGM			**1759.95**
2080 LX6			**1648.95**
2080 HTC	**649.95**	**2080 LX6** MCOG	**CALL**
2120 LX5	**1699.95**	**2120 LX6** MCOG	**CALL**

PREMIER ACCESSORY SALE

LIMITED SUPPLY FIRST COME FIRST SERVED

Meade CAT for Premier 2080 or 2120	**CALL**
CatCom Cat with RS232 Interface	**799**
Digital Readout System for Premier	**239.95**
#39 Dec Motor for Premier Scopes	**84.50**
ECC Hand Controller for Premier Scopes	**229.95**
#1200A Electric Focuser	**CALL**

4500 NEWTONIAN

The new Meade 4500 is the perfect telescope for the beginner. Its 4½ inch f/8 aperture, 900mm focal length optical tube & solid German style equatorial mounting make it ideal for all types of observation. A 1¼" focuser, 6x30 finder and 25mm eyepiece and an aluminum heavy duty tripod are included.

CALL

NEW !

Meade Spotting Scopes

MULTICOATED OPTICS LIFETIME WARRANTY

97E WITH CASE	**323**
97ER Rubber Armored	**339.95**
2045S 4" SPOTTING SCOPE	**SPECIAL**

4" 1000mm F/10 Schmidt-Cassegrain optics with SMC multicoatings and micrometer focus plus a 25mm (40x) 1¼" eyepiece, erect image diagonal & 5x21 finder.

SUPER SPECIALS

Jason 3 1/2" Equatorial Reflector Telescope 90 - 360 Power (Model #327)	**219.95**
CELESTRON ZOOMMASTER II	**CALL**

MEADE ACCESSORIES

LX3 Quartz Electronic Motor Drive	**SPECIAL**
#9068/9070 Digital Readout System	**199.95**
#9060/9061 Digital Setting Circles	**199.95**
#9000 RS CAT with CAT COM	**529.95**
Accessory Case #50 (20"x12"x6.5")	**64.95**
Promo Case #40 for Spotting Scopes	**49.95**
Promo Case #50	**49.95**
Piggyback Bracket for 8"/10" SCT's	**29.95**
#38 Dec for LX3	**55.95**
#38B Dec Motor for MTS Assembly	**39.95**
#43 Drive Corrector	**88.50**
Basic Tele-Extender	**26.95**
Variable Tele-Extender	**36.95**
T Adapters for SCT's	**26.95**
Camera Adapter (1.25") .. **29.95** (.965")	**24.95**
Telecompressor System	**57.95**
#581 Sunshade for 97 Series	**38.95**
#582 Sunshade for 2045D/2045S	**49.95**
Seasonal Star Chart & Luminous Star Finder	**12**

Rack-and-Pinion Focusers (1.25")

#71	**44.95**	#67	**59.95**

Rack-and Pinion Focusers (2")

#680	**85.95**	**#682**	**99.95**

VIEWFINDERS

#637 (6x30)	**39.95**	#545 (8x50)	**59.95**
#957 (9x60)	**89.95**	#544 (8x50)	**59.95**
#967 (9x60) Polar Illuminated			**119.95**
#927 45° Erect Image Diagonal Prism (.965")			**41**
#928 45° Erect Image Diagonal Prism (1.25")			**43**
#929 2" Diagonal Mirror			**89.95**

MEADE EYEPIECES

SUPER PLOSSL

6.4, 9.7, 12.4, 15, 20, 26mm			**79.95**
32 *NEW, 40mm*	**99.95**	56mm (2")	**219.95**

SUPER WIDE ANGLE

13.8mm *NEW*			**129.95**
18mm	**139.95**	24.5mm	**159.95**
32mm (2")	**169.95**	40mm (2")	**179.95**

ULTRA WIDE ANGLE

4.7mm *NEW*	**147.95**	6.7mm	**149.95**
8.8mm (1.25"/2")	**139.95**	14mm (1.25"/2")	**169.95**

ORTHOSCOPIC

4mm, 6mm, 9mm, 12.5mm, 25mm (1.25")	**47.95**

MODIFIED ACHROMATIC

9mm, 12mm, 25mm, 40mm (1.25")	**37.95**
9mm, 12mm, 25mm, 40mm (.965")	**37.95**

BARLOW

#140 Series 4000 2x Apochromatic Barlow Lens	**69.95**
#122 2x Telenegative Barlow (1.25")	**47.95**
#127 2x-3x Variable Barlow (1.25")	**59.95**

MEADE FILTERS

SERIES 4000 COLOR (1.25")

#8 Lt. Yellow, #11 Yellow-Green, #12 Yellow, #21 Orange, #23A Lt. Red, #25A Red, #38A Dark Blue, #47 Violet, #56 Lt. Green, #58 Green, #80A Blue, #82A Lt. Blue	**@12.95**
SET #1 4 Filters: #12 Yellow, #23A Lt. Red, #58 Green, #80A Blue	**42.95**
SET #2 4 Filters: #11 Yellow-Green, #25A Red, #47 Violet, #82A Lt. Blue	**42.95**
SET #3 4 Filters: #8 Lt. Yellow, #21 Orange, #38A Dark Blue, #56 Lt. Green	**42.95**
Series 4000 Moon Filter: ND96	**14.50**

SERIES 4000 NEBULAR

BROADBAND FILTERS *ALL IN STOCK!*

#908B (1.25")	**67.95**	**#910B** (2")	**99.95**
#911B (rear cell thread)			**87.95**

NARROWBAND FILTERS

#908N (1.25")	**89.95**	**#910N** (2")	**119.95**
#911N (rear cell thread)			**109.95**

CELESTRON

REFRACTORS

SP-C102 REFRACTOR

CELESTRON QUALITY OPTICS

THE BEST VALUE 4 INCH EQUATORIAL REFRACTOR

$879.95

COMPLETE FACTORY PACKAGE INCLUDES: 4 inch 1000mm F/9.8 optical tube, Super Polaris equatorial mount with slow motion controls, Illuminated polar aiming scope, azimuth & altitude fine adjustments, setting circles, dew shield, 6x30 finderscope, 26mm (38x) Plossl eyepiece, 1¼" Star diagonal, full height adjustable wooden tripod & accessory tray.

SPC-102F 4" Fluorite Equatorial Refractor .... **CALL**

NEWTONIANS

SUPER POLARIS C6

6 inch 750mm F/5 wide-field Equatorial Newtonian with Super Polaris mount, field tripod, 18mm (42x) eyepiece, 6x30 finderscope **$699.95**

VIXEN 4 1/2" Newtonian

4 1/2" Newtonian Equatorial Mount, 900mm f/7.9, Two eyepieces (50x & 112x), 6x30 finderscope, Adjustable aluminum tripod. *#9117* .... **CALL**

C90 SPOTTING SCOPES

C90 Basic	**326.95**
C90 MC with multicoated optics	**363.95**
C90 Rubberized Multicoated	**399.50**
C90 Rubberized Multicoated with 1¼ inch accessories	**428.95**
Camera Adapter (requires T-mount)	**26.50**
Eyepieces: 10, 16, 18, 25, 40mm Kellner	**29.95**
Eyepieces; 4,5,6,7,9,12mm	**39.50**

CELESTRON 500/5.6 **$285.95**
FEATURING: Multi-Coated Optics, built-in field flattener, lightweight, can be used as a telephoto lens or 90mm Spotting Scope.

SCHMIDT-CASSEGRAINS

SUPER POLARIS C8 with STARBRIGHT

The Celestron Super Polaris C8 with **Starbright enhanced optics** has long been Europe's most popular Schmidt-Cassegrain telescope. These fine instruments combine Celestron's famous 8" 2032mm F/10 optics w/the versatile SP equatorial mount. **INCLUDES:** 8 inch F/10 optical tube, Super Polaris equatorial mount with illuminated polar axis finder, 5x24 finderscope, 25mm Kellner eyepiece, star diagonal, adjustable field tripod & case. **$1024.95**

Super Polaris C8 .... **$889.95**

POWERSTAR 8 PEC

The new Powerstar PEC features Celestron's famed 8 inch Schmidt Cassegrain optics with **Starbright** coatings, PEC periodic error correction DC servo drive system & Byers worm gear for improved tracking accuracy, 30mm Plossl eyepiece, 6x30 finder 1¼" Star Diagonal, case, wedge & rubberized tripod **$1489.95**

***FREE* FOCUS MOTOR ($160 value) with purch.**

ULTIMA 8 PEC

8 inch 2032mm F/10 optical tube with **Starbright** coatings, PEC drive system with hand controller, 30mm Plossl & 7mm Ortho eyepieces, 8x50 Polar illuminated finderscope, 1¼" Star Diagonal, case, wedge & rubberized tripod **$1838**

CLASSIC 8

8" 2032mm F/10 optical tube, rugged swing fork equatorial mount with precision spur gear drive, 25mm Kellner eyepiece, 6x30 finder, 1¼" diagonal, wedge and *Rubberized Field Tripod* **$959.95**

***FREE* FOCUS MOTOR ($160 value) with purch.**

CLASSIC 8 w/Starbright	**1099.95**
C5 NEW Portable Schmidt-Cassegrain	**CALL**
ULTIMA 11 PEC	**3290.50**
CG-11 NEW	**3050**

CELESTRON ACCESSORIES

AC Adapter (PEC)	**22**
DC Inverter (110V)	**74**
Adjustable Tripod Rubberized	**224.95**
Advanced Astromaster (ATM, SP, FORK)	**495.95**
Carrying Case - Powerstar 8 Custom	**139**
Coma Corrector	**174.95**
Counterweight Bar Assembly 8"	**59**
Counterweight Bar Assembly 11"	**64.95**
DEC Motor - Powerstar / Classic 8	**69.95**
DEC or Focus Motor (PEC Scopes)	**69.95**
Dewstar Lens Shade	**24.95**
Lens Shade C90	**54**
Lens Shade C8	**25**
Lens Shade C11	**139**
Stereo Binocular Viewer	**409.95**
F/6.3 Focal Reducer/Corrector	**125.95**
Off Axis Guiding System w/eyepiece	**126.95**
Micro Guide Eyepiece	**133.95**
Mini-Tripod	**21.95**
Motor Drive for C4.5 Comet	**153.95**
Multi Ocular Holder .96"/1.25"	**48.95**
NEW Multi-Function Focal Tester MMFT-55	**155.95**
Piggyback Mount 8"	**32.95**
Piggyback Mt SP-C6 / C80 / C102	**38.95**
Single Axis Motor Drive SP-C8/6/80/102	**129.95**
Dual Axis Motor Drive SP-C8/6/80/102	**289.95**
Polar Axis Finder SP-C8/6/80/102	**74.95**
Radial Guider	**118.95**
Tilt-Plate 0°	**74.95**
Super Polaris 8" Mount with Polaris Finder	**CALL**
Tele Extender	**23.95**
Deluxe Tele Extender	**38.95**
VSP (Vibration Suppression Pads)	**37.95**
6mm Illuminated Reticle	**143.95**
Seasonal Star Chart & Luminous Star Finder	**12**
LED Flashlight	**11.95**
Drive Corrector Heavy Duty	**359**
Star Diagonal Mirror 2" Adjustable	**219**
Star Diagonal 1¼" w/Multicoatings	**39**

CELESTRON EYEPIECES

ORTHOSCOPIC - Up to 45° Apparent Field

5, 6, 7, 9, 12mm .96"	**35.95**
5, 6, 7, 9, 12,mm 1¼"	**45.95**
2X Barlow 1¼"	**38.95**
2X Barlow 2"	**84.95**

ULTIMA SERIES EYEPIECES

5, 7.5, 12.5, 18, 24mm 1¼"	**61.95**
30, 42mm 1¼"	**86.95**
35mm 1¼"	**62.95**
45, 60mm 2"	**159**
80mm 2"	**238**
15, 19, 23mm 1¼" Wide-Angle	**102.95**
2X Barlow Ultima Series 1¼"	**62.95**

CELESTRON FILTERS

.96 Inch: #1A Skylight, #12 Yellow, #21 Orange, #23A Red, #38A Blue, #56, Green, #80A Blue, #96 50% or 25% Neutral Density

1¼ Inch: #1A Sky, #8 #12 #15 Yellow, #21 Orange, #23A #25 Red, #38A Blue, #47 Violet, #56 #58 Green, #80A #82A Blue, #96 50% 25% or 13% Neut. Density

Any of the above filters each	**12.95**
Any 4	**47.95**
.96 or 1¼ inch Polarizer	**14.95**
Sky Filter #2	**35.95**
Series 5/6 Filter Set	**48.95**
LPR A/B 1¼" eyepiece	**58.95**
Filter Adapter .96"	**12**
Filter Adapter 1¼"	**16**

BUSHNELL

DIVISION OF **BAUSCH & LOMB**

SPACEMASTERS

Spacemaster	**127.95**
Armored Spacemaster	**144.95**
Spacemaster Kit with 15-45 Zoom Eyepiece, Mini-Tripod and Case	**217.95**
Armored Spacemaster Kit with 15-45 Zoom Eyepiece, Mini-Tripod and Case	**233.95**
Spacemaster II	**163.95**
Armored Spacemaster II Deluxe Kit **Includes:** 15-45 Zoom Eyepiece, Deluxe Field Tripod, Deluxe Hard Case	**238.95**

ACCESSORIES

Eyepieces (15,20,25,40,60x)	**34.95**
15-45x Zoom Eyepiece	**79.50**
Wide Angle 22x	**44.95**
Camera Mount	**27.95**

Nikon SCOPES

20x60 Rubberized	**168.50**
15-45x60 RC Zoom	**248.95**
20-45x60 Zoom	**353.95**
20-45x60 ED Zoom	**548.95**
20-45x60 ED Wide	**654.95**
15, 30, 40, 60x Eyepieces@	**56**
Photo Attachment	**149.95**
Camera Adapter for Nikon RC Spot. Scopes NEW	**42.95**

BINOCULARS

Meade

7x42	**SPECIAL**
10x42	**SPECIAL**
11x80 NEW Multicoated & Rubberized w/BAK 4 prisms, tripod adapt & case	**SPECIAL**
20x80 NEW Multicoated & Rubberized w/BAK 4 prisms, tripod adapt & case	**SPECIAL**

CELESTRON

HOW TO CHOOSE BINOCULARS	**12.95**
7x42 Ultima	**171.95**
8x32 Ultima	**171.95**
8x56 Ultima	**183.95**
10x42 WA Ultima	**186.95**
10x50 Ultima	**186.95**
11x80 Multicoated w/case & tripod adapt.	**287.95**
15x80 Multicoated **NEW**	**292.95**
20x80 Multicoated w/case & tripod adapt.	**299.95**
8x40 Fixed Focus	**49.95**
30x80 Giant	**249.95**

FUJINON BINOCULARS

The Fujinon SX & F-SX series binoculars are built to full military specification 100% waterproof, multicoated and offer an unprecedented 95% light transmission. The F-SX series binoculars also offer an exceptionally long eye relief of 23mm making them ideal for glasses wearers.

8x40 BFL close focus with focus lock ***NEW***	**241.95**
6x30 FMTR-SX Rubber Armored	**347.95**
7x50 FMT-SX w/carry case	**348.95**
7x50 FMTR-SX Rubber Armored	**398.95**
7x50 FMTRC-SX armored w/compass	**437.95**
8x30 FMTR-SX Rubber Armored	**348.95**
10x70 FMT-SX w/carry case	**436.95**
16x70 FMT-SX w/carry case	**540.95**
Tripod Adapter	**24.95**
Fashion Strap	**12.95**

Nikon

7x50 IF SP Prostar	**568**
10x70 IF	**449.95**
8x40 D Class. Eagle	**536**
10x40 DRC	**363.95**

THOUSAND OAKS OPTICAL

The finest Solar Filters recognized the world over for their quality are now available at Focus Camera.
Call Today for our Great Prices

JMI Jim's Mobile Incorporated

DEC MOTOR		FOCUS MOTOR	
f/Meade LX3/5/6	**73.50**	f/Meade LX3	**77.95**
f/Celestron C8	**74.95**	f/Meade LX5/6	**77.95**
DSC-Max	**488.95**	f/Celestron 8	**77.95**
NGC Micro Max	**458.95**	NGC Max	**788.95**
NGC Mini Max	**567.95**		

THESE ADVERTISED PRICES ARE VALID **FEB. 1 - FEB. 28, 1993** SUBJECT TO PRODUCT AVAILABILITY

focus camera, inc. ORDERS ONLY CALL **800 221-0828** INFORMATION & NY STATE CALL (718) 436-6262

4419-21 13th Ave, Brooklyn, NY 11219

ORDER STATUS & CUSTOMER SERVICE **(718) 871-7608** 24 HOUR FAX LINE **(718) 436-1518**

Orders Shipped Promptly - Most Major Credit Cards, Money-Orders & Personal Checks accepted for payment. COD orders are accepted but may require a deposit, personal checks may require up to 14 days to clear. All orders are subject to verification & acceptance. Shipping handling & insurance are additional, please call/write for exact details. 14-day money back guarantee (less shipping) provided merchandise is returned in new condition, unused as received with papers & packaging intact. **We gladly accept and reply to written or faxed inquiries.** Not responsible for typographical errors. These ad prices are only available while supplies last. This ad supercedes all previous ads. Hours: Mon-Thurs 9-7, Fri 9-2, Sun 10-6.

New Astronomy Products

1

Digitize Your Astrophotos with Kodak's Photo CD

Kodak's recently introduced Photo CD program allows photographers to have their negatives or slides scanned at high-resolution at participating Kodak photofinishers. The dealers transfer the images in digital format to a compact disk; the images can then be viewed on a conventional television. Viewing the disks requires a Photo CD player such as the models now available from Kodak (top) or the new CD-Interactive players recently introduced by Philips. Photo CDs can also be read by Photo CD-compatible CD-ROM XA computer drives.

The Photo CD product line now includes five disk formats (lower): Photo CD Master is the standard format supplied by photofinishers. It can store up to 100 35mm images at full resolution and allows for optional recording of text, graphics, and audio. The second format, Pro Photo CD Master, can store images from film formats larger than 35mm. Photo CD Portfolio can hold up to 800 images at full or reduced resolution. Photo CD Catalog disks can hold 6,000 or more images but at low resolution. Photo CD Medical disks are for recording specialized film-based medical images.

Eastman Kodak Company, 343 State Street, Rochester, NY 14650-0519. Kodak Photo CD players: $399 to $599; Photo CD transfer: $0.58 per image for 35mm images at time of developing (printing and developing extra), or $1.49 to $1.79 per image, depending on quantity, if added later to an existing Photo CD disk. Prices may vary with dealer.

ORION
Discount Catalog of Binoculars & Telescopes
Call Toll-Free 800-447-1001
Over 30 New Products!

2

Binocular Catalog from Orion

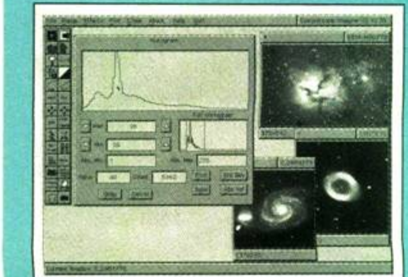
The Orion Telescope Center's new 50-page catalog contains descriptions of over 100 models of binoculars and spotting scopes, as well as helpful advice on selecting binoculars for various applications. The binoculars range from 20mm compact models to 100mm astronomical giants.

Orion Telescope Center, 2450 17th Avenue, P.O. Box 1158, Santa Cruz, CA 95061-1158. Catalog is free.

3

An Automated Personal Observatory

CompuScope's new software and hardware package allows a user to create a fully automated telescope. The Personal Observatory is a special version of CompuScope's IMAGINE-32 image-processing software (reviewed in AstroBytes, October 1992). When combined with CompuScope's interface hardware, the software can control a Meade LX-200 or SSC-series telescope, an ST-4 or ST-6 CCD camera from Santa Barbara Instruments, and CompuScope's FW-1 automated filter wheel. In one operating environment, the user can command the telescope to slew to an object, set the desired filter, control the CCD camera, get an image, and process it. For completely remote access, an infrared sky monitor and a controller to open an observatory by computer will also be available. The Personal Observatory requires an 80386- or 80486-based computer.



CompuScope, 3463 State Street, Suite 431, Santa Barbara, CA 93105, (805) 687-1914, FAX (805) 687-3916. Personal Observatory software: $399; current users of IMAGINE-32 software can upgrade to IMAGINE 32/PO for $100; hardware interface: $99.

4

New Celestron Accessories

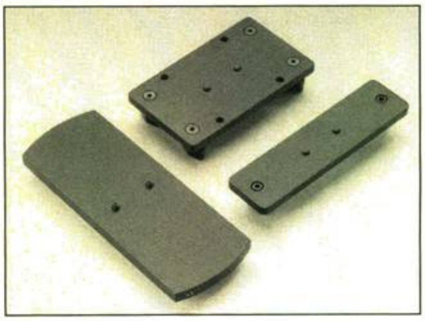
The new Model D LPR or "light pollution reduction" filters (top) are designed for Celestron and other manufacturers' 80mm binoculars. The redesigned Counterweight Bar Assembly (middle) allows for instant adjustment along the length of the tube of a C8 or C11 telescope. One 2.5-pound weight is included. The Deluxe Zoom Ocular (bottom) is said to be the first zoom astronomical eyepiece of high quality ever offered. It has a 1.25-inch barrel and a focal length adjustable from 6.5 to 18 mm.

Celestron International, 2835 Columbia Street, Torrance, CA 90503, (310) 328-9560, FAX (310) 212-5835. Model D LPR filters: $150 for the pair; Counterweight Bar Assembly: $100 for C8, $110 for C11; Zoom Ocular: $200.

5 New Low-Cost Binoculars

Available in 7x50 and 10x50 models, the Royal Optics binoculars feature a 7° field of view, coated optics, and a weight of 23 ounces. Both include case, dust caps, and neck strap, and come with a 30-day money back guarantee.

Royal Optics, 20 Glassco Avenue South, Hamilton, Ontario, Canada L8H 1B3. 7x50 and 10x50: each $89 U.S. or $99 Canadian.



6 Adapter Plates for Tele Vue Telescopes

Owners of the Genesis, Pronto, Renaissance, Oracle, or Solaris telescopes from Tele Vue can attach their telescopes to a Celestron 8-inch fork mount with the new C8 Fork Mount Adapter Plate. The plate attaches between the forks, replacing the Celestron tube assembly. Also shown are Tele Vue's Super Polaris Adapter Plate and Systems Mount Adapter Plate for attaching Tele Vue scopes to these mounts.

Tele Vue Optics, 100 Route 59, Suffern, NY 10901, (914) 357-9522. C8 Fork Mount Adapter Plate: $60; Super Polaris Adapter Plate: $45; System Mount Adapter Plate: $40.

This department presents new product announcements issued by their manufacturers. The product information is as supplied by the manufacturers or distributors. All prices are suggested retail. Suppliers are invited to send their product announcements to the attention of Alan Dyer.

CELESTRON C 4.5

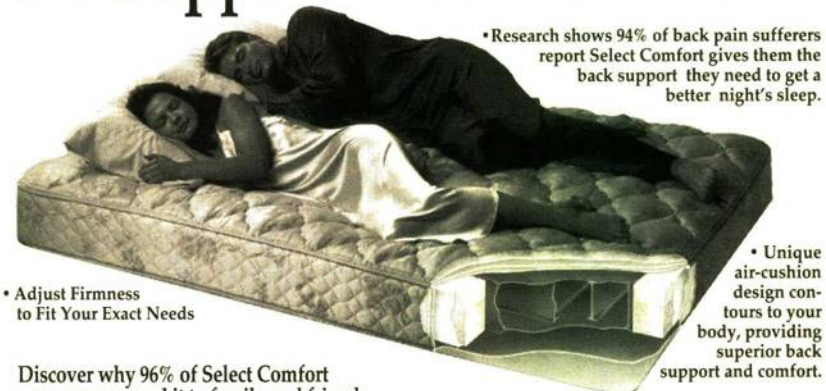
We stock a full line of Meade, Celestron & Tele Vue telescopes and accessories. Call for low prices.

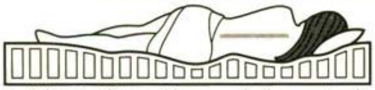
$469⁰⁰ FREE SHIPPING IN CONT. U.S.

Authorized Meade Dealer

WE ARE A FULL LINE MEADE DEALER CALL FOR LOW PRICES!

CITY CAMERA
15336 W. WARREN • DEARBORN, MICHIGAN 48126
ORDER LINE 1-800-359-5085
GENERAL INFORMATION 1-313-846-3922 / 24 HR. FAX 1-313-846-4450
HOURS: MON.-FRI. 9:00 am - 6:00 pm • SAT. 9:00 am - 5:30 pm
ATTENTION CANADIANS
Come into our store and we will pay your Michigan sales tax on any telescope!
WE SHIP ONLY FIRST QUALITY FACTORY PACKED TELESCOPES.
ORDER BEFORE NOON EST AND WE WILL SHIP SAME DAY





Air Support = Back Pain Relief

• Research shows 94% of back pain sufferers report Select Comfort gives them the back support they need to get a better night's sleep.

• Adjust Firmness to Fit Your Exact Needs

• Unique air-cushion design contours to your body, providing superior back support and comfort.

Discover why 96% of Select Comfort users recommend it to family and friends.
"I am a doctor and often come home exhausted. This mattress is the most comfortable I've tried."
Dr. Connie Horn, M.D., Clarksville, OH

Select Comfort provides proper back support and contours to your body, distributing weight evenly.

Innerspring mattresses create pressure points and uneven support.

Waterbeds rely on displacement and can cause a "hammock effect," bending your spine unnaturally.

Revolutionary Air Support System.
Select Comfort's unique air support system lets you control the feel and firmness of your bed — simply by pushing a button. Your mattress can be firmer than the firmest innerspring or softer than the softest featherbed...helping you sleep more comfortably, reducing back pain and muscle aches, and providing true support. Change the firmness whenever you like to meet your exact preference.

- Risk Free 90 Night Trial.
- Variable Firmness = Great Sleep.

Call or Write for a FREE VIDEO and Brochure

1-800-831-1211

Select Comfort Corporation
9301 75th Ave. N., Dept. 1280
Minneapolis, MN 55428

© Select Comfort 1993 Dept. 1280

ASTRONOMY Blue Sky Pages

Your guide to local astronomical dealers

ARIZONA

TUCSON'S COMPLETE ASTRONOMY SHOP

- New and Used Equipment from Celestron to Questar & Accessories
- Books, Posters, Maps & Star-Charts
- Custom Work-Machine & Wood Shop Work Available
- Observatory Construction & Repair
- Observing site and tour guides available.
- Rental equipment available – call for details.
- Repair Work-Telescope Cleaning & Collimating
- Knowledgeable Professional Staff

Stellar-Vision & Astronomy Shop
1835 S. Alvernon #206,
Tucson, AZ 85711 (602) 571-0877

Credit cards accepted. 90 days same as cash.

THE ASTRONOMY SHOPPE

Telescopes • Spotting Scopes • Binoculars
Maps • Books • Eye Pieces & Acces.
"Bigfoot" Mounts • Custom Optics

15836 N. Cave Creek Road
Phoenix, AZ 85032
602-971-3170

CALIFORNIA

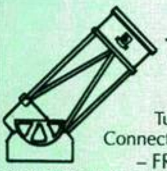
Mirror-Making Kits / Pyrex® Blanks
Grinding & Polishing Compounds
Primary & Elliptical Mirrors

PALOMAR OPTICAL SUPPLY

P.O. BOX 1310
WILDOMAR, CA 92595
(909) 678-5393 • FAX (909) 694-5421 (24 hrs.)

New Catalog Now Available. Send $2.00

COLORADO



AstroSystems, Inc.
Truss Tube Components
Primary Mirror Cells, Spiders, Focusers, Secondary Holders, Tube Clamps, Side Bearings, Tube Connectors, Teflon, Ebony Star Formica.
– FREE CATALOG –
1109 Kimbark St. • Longmont, CO 80501 • 303-678-5339

FLORIDA

CCD IMAGING EQUIPMENT

- Complete CCD Imaging Systems & Accessories
- Image Processing Computers & Software
- Electronic, Remote & Manual Filter Wheels
- CCD Tri-Color, Infrared & UBVRI Filter Sets

MURNAGHAN
1781 Primrose Ln. • W. Palm Beach, FL 33414
Phone: 407-795-2201 • FAX: 795-9889 • BBS: 795-0979

FLORIDA

SARASOTA CAMERA EXCHANGE & VIDEO CENTER

1055 South Tamiami Trail
Sarasota, Florida 34236

TELESCOPES
Celestron • New Meade • Tele Vue
Large Accessory Inventory • Used Telescopes

BINOCULARS
B & L • Bushnell • Celestron • Leica • Meade
Minolta • Nikon • Pentax • Steiner

Microscopes and Accessories

(813) 366-7484 Call or write Chuck, our dedicated astronomer.

GEORGIA

Celestron - Meade - JMI
New - Used - Demos - Closeouts

COKE'S CAMERA CENTER

Ask for Bob or Jim
735 Cherry St., Macon, GA 31213
1-800-768-2653 • 9:00 am - 5:30 pm

KANSAS

Science Education Center

Celestron Sales & Service
New and Used Telescopes
Spotting Scopes – Binoculars

We take trade-ins

125 S. Hillside • Wichita, KS 67211 • 316-682-1921

NEW HAMPSHIRE

(WE BUY USED TELESCOPES)
Large in-store display. Celestron, Meade, Tele Vue accessories. *Since 1930*

Rivers CAMERA SHOP

454 Central Ave. • Dover, NH 03820
(603) 742-4888 • FAX (603) 742-5456
Hours: 8:30-6:00 Mon.-Thurs. • 8:30-8 Fri. • 8:30-5:30 Sat.

NEW JERSEY

Celestron, Meade, Tele Vue,
Leica, Steiner, Nikon,
Bausch & Lomb, Bushnell, Swift

DOVER PHOTO SUPPLY

25 E. Blackwell St., Dover, NJ 07801
(201) 366-0994 (9 am to 5:30 pm)

NEW YORK

BERGER BROS.
CAMERA EXCHANGE

TELESCOPES • BINOCULARS • CAMERAS • CAMCORDERS
Over 45 years in business. Honest Reputation.
BERGER BROTHERS CAMERA & VIDEO EXCHANGE
209 Broadway • Amityville, NY 11701 • **Info:** (516) 264-4160
Orders: 800-262-4160 • **Fax:** (516) 264-1007

OHIO

METZGER
PHOTO & VIDEO CENTERS

Meade, Celestron, Bushnell;
Telescopes and Binoculars
701 S. Main Street • Akron, OH 44311
1-800-860-2772

OREGON

NURNBERG SCIENTIFIC

6310 S.W. Virginia Ave. • Portland, Oregon 97201
Call Stan, our astronomy enthusiast, for expert personal assistance in choosing a fine Tele Vue, Meade or Celestron telescope and accessories.
We also carry our own full line of microscopes.
(503) 246-8297 • Hours: Monday - Friday 8:30 to 4:30

PENNSYLVANIA

AMATEUR ASTRONOMERS!
TELE VUE GENESIS & PRONTO SCOPES AT SPECIAL SALE PRICES!

- **Special Packages with new GIBRALTAR mount.**
- **New Tele Vue Genesis Solar Kit in stock.**
- **Daystar H-Alpha Filters available.**

★ **See Solar Prominences with the Genesis every Saturday at our showroom.**

Celestron • All Meade • Questar • Parks • Brandon • Edmund
University Optics • JMI • Thousand Oaks Solar Filters
B&L • Vogel • D&G • Kowa • Zeiss • Swarovski • Swift
Fujinon • Lumicon • Spectra • Beattie Screens

E-Z Cosmos, Star Gaze, The Sky, Distant Suns, and Dance of the Planets software available
Bogen Tripods • Pentax • Steiner • Minolta
All charts and publications. Send SASE for free price list
$5.00 for complete catalog package
✹ **We ship everywhere** ✹
SEE OUR ADS ON PAGES 23 & 87.

Wholesale Optics of Pennsylvania

RR 6 Box 6329, North Pocono Village Shopping Ctr.
Moscow, PA 18444 • (717) 842-1500 (9am-9pm)
Fax (717) 842-1408 (24 hrs.)
Showroom hours: 10-5 Mon – Saturday

ASTRONOMY Blue Sky Pages

Your guide to local astronomical dealers

PENNSYLVANIA

OPTICAL GUIDANCE SYSTEMS

Custom-Made Ritchey - Chretien,
Classical Cassegrain and
Newtonian telescopes 10-32 inches.

2450 Huntingdon Pike
Huntingdon Valley, PA 19006
(215) 947-5571

SOUTH CAROLINA

Wonder Works

S.C. LARGEST SELECTION OF TELESCOPES:
Spotting scopes, binoculars & opera glasses
Celestron & Meade Dealers
Best prices, selection assistance, & free instruction.
PHONE ORDERS WELCOME • OPEN 7 DAYS
280 W. Coleman Blvd. • Mt. Pleasant, SC 29464 • 800-352-2316

WISCONSIN

EAGLE OPTICS

Binoculars, Telescopes,
Star Charts & Accessories

716 S. Whitney Way Madison, WI 53711
(608) 271-4751

CANADA, MANITOBA

COSMIC CONNECTION

32 Ashgrove Blvd. • Brandon, Manitoba R7B 1C2
(204) 727-3111

Expert Advice on Telescopes, Binoculars & Books
Celestron, Lumicon, Vixen, Omcon and More!

Canada-Wide Mail Order Service

Send $4 for our big catalog of values!

CANADA

Telescopes, Binoculars, Books

"Exclusive Mail Order Source for Meade Advanced Products in Canada."

- Expert Advice
- Low Prices
- Canada Wide Delivery

SEND $3.00 FOR MAIL
ORDER CATALOG
ALL MAJOR BRANDS

KHAN SCOPE CENTRE

3243 Dufferin Street • Toronto, Ontario, M6A 2T2
(416) 783-4140

CANADA

1857 **HARRISON**

Serving Canadians for over 135 years

Telescopes, Binoculars, Microscopes, Magnifiers, Accessories, Books, Meteorological Instruments, Gadgets, T-Shirts and Sweat Shirts

• Celestron • Minolta • Meade • Bushnell
• Bausch & Lomb • Pentax • Zeiss • Steiner

Fast Canada-wide Delivery
Will match any advertised Canadian retail price

Montreal – Fax (514) 341-1184 • (514) 341-2079
8425 Mountain Sights Ave. • Montreal, Quebec H4P 2B9
Vancouver – (604) 737-4303
2574 Granville Street • Vancouver, B.C. V6H 3C8

Here's what advertisers are saying about ASTRONOMY'S *Blue Sky Pages...*

*"The **Blue Sky Pages** are an excellent way to attract attention to my business. The format of the section makes it easy for readers to find COSMIC CONNECTION and my increasing sales prove it! I think an ad in the **Blue Sky Pages** is just one more way to better serve my customers.*

Mr. Jeff Harland
COSMIC CONNECTION
Brandon, Manitoba, CANADA

For advertising information call (800) 558-1544

ASTRONOMY "Blue Sky Pages" Order Form

Advertise in the "Blue Sky Pages"

The "Blue Sky Pages" offer many advantages including:
- Ads separated by state and/or country headings.
- FREE attention getting blue color.
- A variety of sizes to suit your individual purposes.
- Astronomy related artwork to compliment your ad.
- Frequency discounts.

Issue(s) (Choose the months you would like your ad to appear.)

☐ Jan. ☐ Mar. ☐ May ☐ July ☐ Sept. ☐ Nov.
☐ Feb. ☐ Apr. ☐ June ☐ Aug. ☐ Oct. ☐ Dec.

Rates

☐ 1 – 5 ads per year: $135 per inch
☐ 6 – 11 ads per year: $130 per inch
☐ 12 or more ads per year: $120 per inch

Rates include ad production. Astronomy related artwork is available free of charge.

Ad Sizes

☐ 1″ ☐ 2″ ☐ 3″

Closing date

10th of the month three months before the cover date.

Attach copy on a separate sheet of paper.

Name ....

Company ....

Address ....

City/State/Zip ....

Phone .... Fax ....

Signature .... Date ....

☐ Please charge my Kalmbach account # ....

☐ Check payable to Kalmbach Publishing Co. enclosed

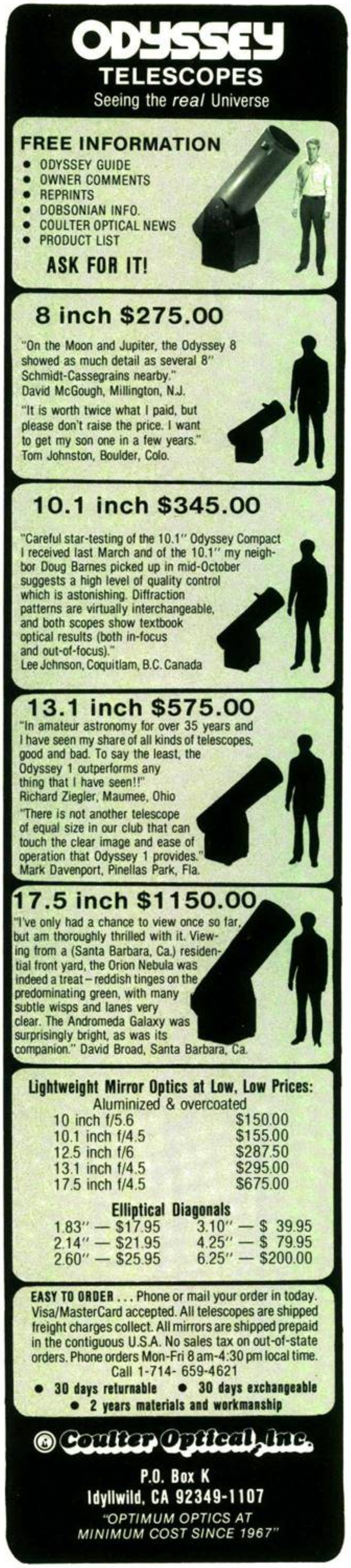
Charge my: ☐ Visa ☐ M/C ☐ Am. Express

Card # ....

Exp. Date ....

Or for faster service call Mary Bohn at **800-558-1544**, ext 538.

Send to Blue Sky Pages, ASTRONOMY, 21027 Crossroads Circle, P.O. Box 1612, Waukesha, WI 53187-1612. Fax 414-796-0126. Outside the U.S. and Canada call 414-796-8776.



ODYSSEY
TELESCOPES
Seeing the *real* Universe

FREE INFORMATION

- ODYSSEY GUIDE
- OWNER COMMENTS
- REPRINTS
- DOBSONIAN INFO.
- COULTER OPTICAL NEWS
- PRODUCT LIST

ASK FOR IT!

8 inch $275.00

"On the Moon and Jupiter, the Odyssey 8 showed as much detail as several 8" Schmidt-Cassegrains nearby."
David McGough, Millington, N.J.

"It is worth twice what I paid, but please don't raise the price. I want to get my son one in a few years."
Tom Johnston, Boulder, Colo.

10.1 inch $345.00

"Careful star-testing of the 10.1" Odyssey Compact I received last March and of the 10.1" my neighbor Doug Barnes picked up in mid-October suggests a high level of quality control which is astonishing. Diffraction patterns are virtually interchangeable, and both scopes show textbook optical results (both in-focus and out-of-focus)."
Lee Johnson, Coquitlam, B.C. Canada

13.1 inch $575.00

"In amateur astronomy for over 35 years and I have seen my share of all kinds of telescopes, good and bad. To say the least, the Odyssey 1 outperforms any thing that I have seen!!"
Richard Ziegler, Maumee, Ohio

"There is not another telescope of equal size in our club that can touch the clear image and ease of operation that Odyssey 1 provides."
Mark Davenport, Pinellas Park, Fla.

17.5 inch $1150.00

"I've only had a chance to view once so far, but am thoroughly thrilled with it. Viewing from a (Santa Barbara, Ca.) residential front yard, the Orion Nebula was indeed a treat – reddish tinges on the predominating green, with many subtle wisps and lanes very clear. The Andromeda Galaxy was surprisingly bright, as was its companion." David Broad, Santa Barbara, Ca.

Lightweight Mirror Optics at Low, Low Prices:
Aluminized & overcoated

10 inch f/5.6	$150.00
10.1 inch f/4.5	$155.00
12.5 inch f/6	$287.50
13.1 inch f/4.5	$295.00
17.5 inch f/4.5	$675.00

Elliptical Diagonals
1.83" — $17.95
2.14" — $21.95
2.60" — $25.95
3.10" — $ 39.95
4.25" — $ 79.95
6.25" — $200.00

EASY TO ORDER . . . Phone or mail your order in today. Visa/MasterCard accepted. All telescopes are shipped freight charges collect. All mirrors are shipped prepaid in the contiguous U.S.A. No sales tax on out-of-state orders. Phone orders Mon-Fri 8 am-4:30 pm local time.
Call 1-714- 659-4621

- **30 days returnable**
- **30 days exchangeable**
- **2 years materials and workmanship**

Coulter Optical, Inc.

P.O. Box K
Idyllwild, CA 92349-1107
"OPTIMUM OPTICS AT MINIMUM COST SINCE 1967"

Meetings & Events

February 13-21
40th Anniversary Celebration, Museum of Natural History. Write to Cormack Planetarium, Museum of Natural History, Roger Williams Park, Providence, RI 02907-3600. Contact: Michael Umbricht. Phone (401) 785-9457.

February 15-21
9th Annual Winter Star Party, Camp Wesumkee, Florida Keys, Florida. Sponsored by the Southern Cross Astronomical Society. Contact: Bob or Sharon Grant, 5401 SW 110th Avenue, Miami, FL 33165. Phone (305) 595-8778.

February 27
2nd Annual EMU Astronomy "Freeze Out," Eastern Michigan University. Sponsored by the EMU Astronomy Club. Contact: Norbert Vance, 303 Strong Hall, Ypsilanti, MI 48197. Phone (313) 487-4144. Observatory message (313) 487-3033.

February 28
Astronomy Sunday, Trailside Nature and Science Center. Sponsored by the Trailside Nature and Science Center, Mountainside, New Jersey. Write to County of Union, Division of Parks and Recreational Services, Coles Avenue & New Providence Road, Mountainside, NJ 07092. Phone (908) 789-3670.

March 6
Astrophoto X Seminar, Ruby Gerontology Center, California State University at Fullerton. Sponsored by the Orange County Astronomers, Ventura County Astronomical Society, and physics department at Cal State Fullerton. Contact: John Sanford, Orange County Astronomers, 2195 Raleigh Avenue, Costa Mesa, CA 92627.

March 17-19
Satellites and Education Conference IV, West Chester University, West Chester, Pennsylvania. Sponsored by the School of Education, NASA, GE Astro Space, Pennsylvania Space Grant Consortium, and the National Oceanic and Atmospheric Administration of the U.S. Department of Commerce. Contact: Nancy McIntyre, West Chester University, PA 19383. Phone (215) 436-2323.

March 20
2nd Annual Messier Night, Lake Hudson State Recreational Area, Clayton, Michigan (alternate cloud date of March 27). Sponsored by the Astronomical Societies of Lenawee and Hillsdale Counties. Write to the Astronomical Societies of Lenawee and Hillsdale Counties, P.O. Box 229, Hudson, MI 49247. Phone (517) 448-7173 days or (517) 547-7402 evenings.

April 8-11
Houston Future Fest, Hyatt Regency Downtown, Houston, Texas. The public is welcome at this science fiction convention, but admission to most of the events and activities will require paid registration. Future Fest, P.O. Box 1770, Friendswood, TX 77546-1770. Phone (800) 787-5317.

April 10
Northeast Astronomy Forum, Rockland Community College, Suffern, New York, (Exit 14B off I-287). Sponsored by the Rockland Astronomy Club. Contact: Don Urban, Rockland Astronomy Club, 73 Haring Street, Closter, NJ 07624.

April 5-7
Second Solar Astronomy Convention, La Paz, Baja California Sur, Mexico. Sponsored by the La Paz Station of the Solar Astronomy Research Center. Write to Calle La Purisima 119, Colonia Bellavista, Codigo Postal 23050, La Paz, Baja California Sur, Mexico. Phone 91-682-1-07-32.

May 1
Astronomy Day, Groveland, Massachusetts. Sponsored by the North Shore Amateur Astronomy Club. Contact: Paul Graveline. Phone (508) 470-1970.

May 17-23
Texas Star Party, Prude Ranch, near Fort Davis, Texas. Hosted by the Southwest Region of the Astronomical League. Contact: TSP Registrar, 1326 Mistywood Lane, Allen, TX 75002.

July 29-31
ALCON '93, Sheraton Inn and Conference Center, Madison, Wisconsin. Hosted by the Madison Astronomical Society. Write to Madison Astronomical Society, ALCON '93, P.O. Box 14747, Madison, WI 53714-0747

July 31 - August 2
Stellafane, Springfield, Vermont. Write to Stellafane, P.O. Box 50, Belmont, MA 02178. ☐

Clubs, please submit announcements at least four months in advance. Readers, include a self-addressed, legal-sized envelope with your request for information.

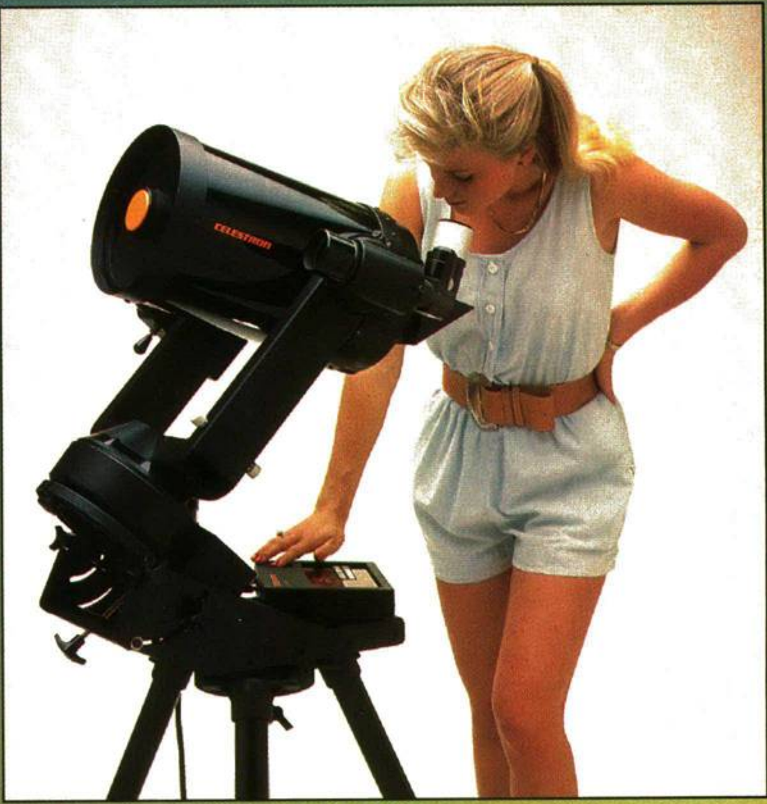
Celestron
COMPUSTAR 8 TELESCOPE
Computer Controlled

The Compustar's raw awesome power is incredible. It makes observing fun as you program what you want to see.

Compustar standard features include:

- Incredibly fast slewing (12 degrees per second)
- Database includes over 8000 objects (the Messier catalog, NGC objects, notable stars)
- Ability to select brightness, viewing horizon, category of object and length of observing time per object
- Automatic polar alignment assistance
- Automatic compensation for atmospheric refraction and precession
- Deluxe tripod
- 8x50 finderscope
- 1-1/4" star diagonal, 1-1/4" 30mm Ultima ocular
- Heavy duty wedge to eliminate field rotation
- Deluxe foam fitted carrying case
- Last but not least, the finest Schmidt-Cassegrain optics (8" f/10)

Numerous accessories are available for the Compustar. One of the most popular is the optional joystick that puts you in full control – like being at the stick of an F-15. Celestron's Compustar was the first introduced and is still the leader in computer controlled telescope technology. Take a minute to compare Celestron's Compustar with the competition . . .



Compustar 8 #11012
Shown with optional 2" accessories

	OURS	THEIRS
Product Life	1st introduced and still the best!	
Speed	50% faster slewing. 12 degrees per second	
Standard Database	10x larger	
Heavy duty wedge	Standard	Optional
Optics	The finest Celestron Schmidt-Cassegrain optics	
Freight charges	Minimal, if any.	Excessively high

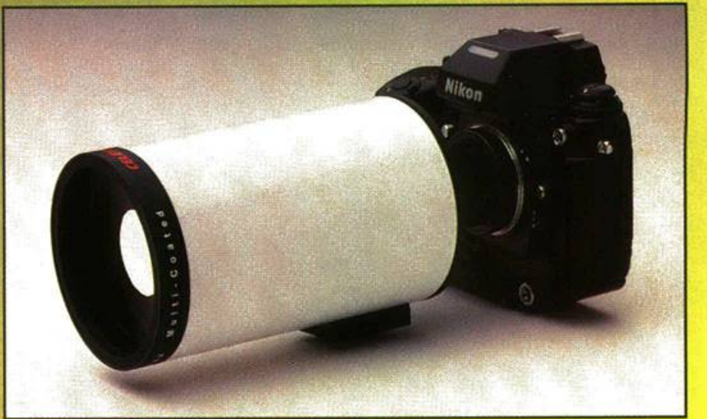
Stay with the leader in proven performance – Celestron and the Compustar 8.

Multipurpose Telephoto Lens 500mm f/5.6

A fast, compact lens of a Maksutov-Cassegrain optical design. An optional accessory converts the lens to 350mm at f/4! Weight is only 43 oz.!

Important features of this instrument:

- Multi-coated optics to improve contrast
- Built-in field flattener to reduce field curvature
- Close focus of 5' (3-1/2' with f/4 accessory)
- Built-in tripod adapter
- Deluxe soft case
- Nearly full 35mm illumination
- Micrometer type focusing
- Blackened lens edges



500mm f/5.6 Telephoto Lens #81005

CELESTRON®
Celestron International
2835 Columbia Street, Torrance, CA 90503 • 310/328-9560 310/212-5835 (FAX)
LIGHT YEARS AHEAD OF THE COMPETITION

ADORAMA INC.

42 WEST 18th STREET • NEW YORK, NY 10011
CUSTOMER RELATIONS • 212-741-0466 • Mon–Thur. 9–4:30, Sun. 11-2 ET

FAX #
212/ 463-7223

PHONE ORDERS ACCEPTED
DAY OR NIGHT
MON–THURS. 9 TILL 9:30 PM EST
FRI. 9-1:45 • SUNDAY 9:30–6

STORE HOURS:
MON.–THURS. 9–7pm
FRI TO 1:45 • SUN 9:30–5:45

ORDER TOLL FREE • US & CANADA
800-223-2500

ORDERS & INFO
212-741-0052

COMPLETE with MANUFACTURER'S ACCESSORIES

Meade®

THE LEADER'S EDGE

We Carry The Complete Line!

Premier 8" & 10" Schmidt-Cassegrain
At greatly reduced prices

The **2080 8" model 50B,** includes the following features:
- 8" f/10 optical tube with **MCOG** • **LX6 Drive**
- Powered 3 ways (1) AC (2) 12V DC (3) AA battery pack
- Electronic control center • Wedge & field tripod
- 9x60 FinderPolar illuminator, 2" star diagonal, 26mm super Plossl. *All this for only* **$1199⁹⁵**

2120 10" Model 50 & 56 Include: • 10" f/10 (model 50) or 10" f/6.3 (model 56) with MCOG.• **LX6, Smart Drive,** With all the accessories of the 2080 model 50 mentioned above plus a free 12.4 Super Plossl Eyepiece **1799⁹⁵**

We are one of the largest Meade stocking dealers on the East coast with the full line of **Meade** on display

Before you make your purchase, call us for our low prices and don't forget to visit our large display of Telescopes there you can see all the latest wonders from **Meade**

MEADE EYEPIECES Series 4000

Super Plossl		Ultra Wide		Super Wide	
6.4,9.7,12.4, 20	**74.95**	4.7mm	**139.95**	13.8mm	**124.95**
15,26	**59.95**	6.7mm	**174.95**	18mm	**129.95**
32mm	**94.95**	8.8mm (1.25"/2")	**137.95**	24.5mm	**149.95**
40mm	**94.95**	14mm (1.25"/2")	**172.95**	32mm (2")	**209.95**
56mm (2")	**134.95**	Barlow 2X Ser 4000	**69.95**	40mm (2")	**189.95**

Orthoscopic Series 2 Eyepieces 4, 6, 9, 12.5, 1/4" **43.95**

MEADE TELESCOPE ACCESSORIES

Accs. Case #50	**59.95**
Accs Shelf for Tripod	**24.95**
2X Barlow 1.25" #122	**45.95**
Variable 2X,3X 1.25 #127	**56.95**
2" Star Diagonal	**89.95**
Off Axis Guider	**79.95**
12mm Illum Reticle w/wire	**67.95**
Illum Reticle wireless	**88.95**
45° Erect Prism	**47.95**
Photo Visual Filt Set 4 pc	**47.95**
#1A Sky Filter	**44.95**
#908B Nebular Filter 1 1/4"	**61.95**
#911B Nebular Filter	**89.95**

#LED. Maplight f/LX3	**29.95**
Dec #38 f/LX3	**79.95**
Dec #39	**69.95**
Dew Shield (2080)	**103.95**
Dew Shield (2120)	**114.95**
Piggy Bk Brkt 2080/2120	**29.95**
Tube 1401 Weight Set	**69.95**
Tube 1402 Weight	**74.95**
Tele Extender	**24.95**
Tele Extender Variable	**37.95**
9x60 Polar Illuminated Finder w/Bracket	**139.95**
#43 R.A. Drive	**81.95**

Meade Reflectors / Refractors

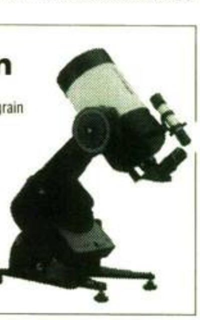
Call For Prices

REFRACTOR & REFLECTOR TELESCOPES

4.5 Reflector. w/Equatorial Mount	**Call**
Altazimuth Refractor	**Call**
Equatorial Refractor	**Call**
Basic Camera Adapter 1 1/4"	**29.95**
Variable Projection Camera Adapter 1 1/4"	**39.95**
2045S Spotting Scope	**399.95**
Carry Case for 2045-S	**44.95**

New Celestron

5" compact scope
New C5 1250 F/10 Schmidt Cassegrain
with Starbright coating.
Available in 3 versions:



C5 Telescope w/AC Drive	819.95
C5 Telescope w/AC & DC Drive	999.95
C5 Spotting Scope	624.95
C5 Tripod	229.95
Radial Guider C5	129.95
DEC Motor C5	99.95

BUSHNELL

BAUSCH & LOMB DISCOVERER

DISCOVERER with 15-60x Zoom	**168⁹⁵**
Discoverer Case	**44.95**
Tamrac Case for Discoverer	**19.95**
Camera Mount	**14.95**
Car Window Mount	**34.95**

Bausch & Lomb 800mm Mirror Spotting Scope

800 f/10 Compact Unit (only 8" long) **239.95**

SPACEMASTER (60mm)

Spacemaster	**129.95**
New **Spacemaster ED**	**289.95**
Spacemaster Rubber Armored	**146.95**
Spacemaster with 15-45x, Table Tripod & Case	**219.95**
Spacemaster Rubber with 15-45x Table Tripod & Case	**234.95**

SPACEMASTER ACCESS.

15, 20, 25, 40 & 60x EP	**34.95**
22x Wide Angle	**46.95**
15-45x Zoom Eye Piece	**79.95**
Camera Mount	**29.95**

ELITE PC

611548PC #ELITE with Zoom E.P. .... **Call**

Tele Vue®

"Tops in the Field"

NEW PLOSSL

55mm 2"	**Call**
40, 32mm 1 1/4"	**Call**
26, 21, 17, 13mm 1 1/4"	**Call**
10.5, 7.4mm, 1 1/4"	**Call**

WIDEFIELD

40mm 2"	**Call**
32mm 2"	**Call**
24mm 1 1/4"	**Call**
19mm 1 1/4"	**Call**
15mm 1 1/4"	**Call**

BARLOW

2.5X, 1.8X 1 1/4"	**Call**
Big Barlow 2x 2"	**Call**

NAGLER

20mm Type 2; 2"	**Call**
16mm Type 2; 2, 1 1/4"	**Call**
12mm Type 2; 2, 1 1/4"	**Call**
13mm 2" & 1 1/4"	**Call**
9mm 2" & 1 1/4"	**Call**
7mm 1 1/4"	**Call**
4.8mm 1 1/4"	**Call**

NEW PANOPTIC

22mm 1¼"	**Call**
35mm 2"	**Call**
Panoptic Barlow Interface 2"	**Call**

ACCESSORIES

2" Star Diagonal	**Call**
Rich Field Kit w/New 55 Plossl 2" S.D., Adapt, 2" to 1 1/4" Adapt	**349.95**
1¼" E.P. Adt. f/Questar	**59.95**

PARACORR COMA CORRECTORS

1 1/4"	**Call**
2"	**Call**

TELEVUE REFRACTORS

Genesis

Fluorite-APO Refractor

Achieves color correction far superior to ordinary "achromatic doublets". The 4-element patented Nagler design also produces a highly corrected flat-field. Despite the unusually fast f/5 speed, Genesis retains the unsurpassed resolution of classic long-focus refractors. Yet, compared to f/15 instruments, it is 9 times faster photographically, and covers 9 times the viewing area!

Specifications
- Aperture—101mm (4")
- Focal length—500mm
- Speed—f/5
- Magnification—9x to 260x
- Resolution—1.1 arc sec, (Dawes limit) 280 LP/mm, photographic
- Field—285' at 1000 Yds. 5.4° at 9x
- Length—28"
- Weight—10 lbs. (tube assy.)

CALL FOR SPECIAL PRICE

GENESIS OUTFIT includes Genesis Telescope w/2" Mirror, 26mm plossl, carry case and Celestron's Super Polaris Equatorial Mount, Polar Axis Scope, with Illuminator *all for only* **$1799⁹⁵**

RENAISSANCE 4" f 5.5 Brass Refractor .... **Call**

PRONTO 70mm Aperture f/6.4 w/ED Glass

PRONTO w/2" star diagonal & 21mm Plossl	**Call**
PRONTO w/1.25" erect prism & 21mm Plossl	**Call**

MOUNTS & ACCESSORIES FOR TELEVUE REFRACTORS

New **GIBRALTAR MOUNT** **449⁹⁵**

Gibraltar–An exceptionally easy to use, sturdy and smooth American made mount ready to accept the latest computer locating devices

TV Panoramic w/Wood Tripod Alt-Azimuth Mount	**339.95**
Panoramic mount w/alumin. tripod	**284.95**
Tele Pod Alt Azimuth Mount	**229.95**
Tele Vue Equatorial System Mount w/Wood Tripod, Adpt	**799.95**
Adapter for Celestron fork mount	**49.95**
Starbeam ."Red Star" Projection Finder	**Call**
Piggy-Cam .Camera Adapter	**Call**

Edmund Scientific

Astroscan 2001 288⁹⁵

Edmund Scientific's affordable wide-field, go-anywhere telescope gives super bright images.

RKE Eyepieces 1 1/4"	**39.95**
8.4-21 Zoom Ortho	**96.95**
2.5 Rke Barlow	**66.95**
Variable Barlow	**36.95**
Straight Image Erctr	**59.95**

R.A. Prism Erector	**51.95**
Variable Cam. Adapt	**69.95**
Tripod Bracket	**43.95**
Carry Bag	**32.95**
Sun Screen	**49.95**

3" f/6 Reflector **179.95**

CELESTRON®

SCHMIDT CASSEGRAIN TELESCOPES

Ultima 8 P.E.C. (Periodic Error Correction)	**1799.95**
Focus Motor for Ultima 8 P.E.C. w/purchase of Ultima.	only **39.95**
New Ultima 11 P.E.C. w/Massive wedge counterwighting piggyback bracket	**3399.95**
Ultima 11 P.E.C.	**2899.95**
COMPUSTAR w/8000 object library, Wedge tripod & 12 volt heavy duty battery	*only* **1899.95**
New CG-11 Telescope	**Call**
CG-11 Mount only	**1699.95**
NEW lens shade 11"	**149.95**
New Improved DEC Motor for P.E.C.	**69.95**
Powerstar 8 P.E.C.	**1399.95**
CLASSIC 8 SBC OUTFIT with Tripod and Wedge	only **959.95**
DEC Motor or Focus Motor for Classic	**99.95**
Super Polaris C8	**889.95**
Super Polaris C8 with Starbright Coating	**1019.95**
Single Axis Drive for Super Polaris	**156.95**
Dual Axis Drive for Super Polaris	**264.95**
8" f/10 Schmidt Cassegrain Optical Tube Assembly with 5x24 Finder, 25mm 1.25", Star Diagonal 1.25", Footlocker Case	only **$499⁹⁵**
8" Optical tube as above with star bright coating	**649.95**
11" f/10 optical tube assembly, 8x50 finder w/LED illum. Reticle, 30mm ultima 1.25", star diagonal 1.25"	**1799.95**

ADVANCED ASTRO MASTER

New Advanced Astro Master (f/fork mounted C8s & SP Mounts) ... **539.95**

NEW COMA CORRECTOR

With 1¼", 2" Eyepiece & Focus Adapter **189.95**

REDUCER CORRECTOR

f/6.3 Focal Reducer Corrector .... only **125.95**

Multi Function Focal Tester 5S

Focus on & off the optical axis at 3,16,22 & 30mm Diam. in a single setup .... only **139.95**

RADIAL GUIDER

Allows free movement of guider while camera is fixed . **109.95**

6mm Illum. Reticle
w/moveable reticle **144.95**

REFLECTOR TELESCOPES

Super Polaris 6" (SPC 6)	**719.00**
C4.5" Newtonian	**399.95**
Motor Drive f/C4.5 Comet Catcher	**179.95**
Polar Axis Finder w/Illum f/C6, CC, C4.5	**62.95**
Polar Axis Finder w/Illum f/SP Mounts	**84.95**
Tele Extender Refractor/Newtonian	**44.95**

REFRACTOR TELESCOPES

Super Polaris C102 102mm	**885.95**
Super Polaris C102 Fluorite	**1699.95**
Firstscope 80 w/45 Erect Prism	**429.95**
Firstscope 80 Brass	**649.00**
New Super Polaris 80mm (SPC 80)	**589.95**
T Adapter Refractor/C4.5	**39.95**
Tele extender w/T Adapter (Refrect Newtons)	**59.95**
60mm Altazimuth	**119.95**
60mm Equatorial	Only **189.95**
Correct Image Eyepiece f/60mm Ref	**9.95**
T Adapt/Tele Extender f/60mm Ref	**49.95**

SPOTTING SCOPES

All the C90s Include: 8x20 Erect Image Finder, 45° Erect Image Diagonal, 30mm, .96" E.P., Foam Fitted Case

C90	**326.95**
C90 MC	**363.95**
C90 Rubber MC	**399.95**
New **C90MC w/1.25" Accs.**	**409.95**
New **C90MCRC w/1.25" Accs.**	**428.95**
C65 Rubber Coated	*SPECIAL* **119.95**
C60 Rubber Coated	**229.95**
SS-80 w/45° Erector, 18mm 1.25" E.P.	**279.00**
555 f/5.6 Telephoto	**289.95**

NEW CELESTRON SPOTTERS

20x60	**359.95**
30x60	**359.95**
20x60 ED	**519.95**
C60 Zoom	**319.95**

CELESTRON C90 & SPOTTING SCOPE ACCS.

Barlow .96, 2x	**33.95**
5,6,7,9,12 Ortho, .96	**36.95**
Barlow .96" 2.5x	**24.95**
10,16, 18, 25, 30, 40 Klnr.96	**32.95**
Mult Ocular .96 Hold	**49.95**
Porro Prism .96	**44.95**
Straight Image Corr. 1.25" f/C90	**19.95**

Diag Prism 45° .96	**47.95**
1.25" Diag Prism 45° .for C90	**49.95**
Series 5 Filter Set	**69.95**
Skylight Filter #1	**34.95**
T Adapt. C90	**30.95**
Shoulder Mount	**64.95**

CELESTRON TELESCOPE ACCS.

Improved Accs Cs	**44.95**
Barlow 1 1/4" 2x	**39.95**
Barlow 2" 2x	**89.95**
New Counterweight Bar Assembly 8" **69.95** 11"	**74.95**
DC Inverter	**78.95**
45 Erect Prism 1 1/4"	**49.95**
Dewstar/Shade 8"	**27.95**
8x50 RA Pol Find C8	**154.95**
Quick Release f/8x50 find	**47.95**
Focus Motor 11, 14	**119.95**
New LED Flashlight	**17.95**
New LPR A	**59.95**
New LPR B	**89.95**
Mult Ocular Hldr 1 1/4"	**124.95**
Piggyback Mt 8"	**36.95**
Piggyback Mt SPC6/SPC102	**54.95**
Polarizer Set 1 1/4"	**49.95**
Series 6 Filter Set	**69.95**

Stereo Binocular Viewer	**409.95**
Star Diag 1 1/4 MC	**52.95**
New Improved 2" Mirror Star Diagonal w/1.25" Adapt.	**109.95**
2" Prism Diagonal	**249.95**
Super Polaris 8" Mount with Polaris Finder	**499.95**
Sky Filter #2	**39.95**
Adj. Tripod Rubberized	**224.95**
Tele Extender	**24.95**
Tele Extender Deluxe	**49.95**
T. Adapter f/Schmidt Cassigrains	**24.95**
Wheels f/Adj Tripod	**39.95**
Vibration Suppr. Pads	**39.95**
Wedge f/C8	**87.95**
New Wedge f/11	**369.95**
New Tilt -Plate 0°	**79.95**

CELESTRON MYLAR SOLAR SCREEN FILTERS (MOUNTED)

f/60 Ref	**43.95**	f/C90s	**64.95**	f/C90s Rubbe	**69.95**
f/c4.5	**69.95**	f/C102	**84.95**	f/C8s	**104.95**

CELESTRON 1¼" EYEPIECES

5,6,7,9,12,25mm, Ortho	**46.95**
25mm Kellner	**39.95**
Zoom Ocular (8.4-21mm) Ortho	*only* **89.95**
New Deluxe zoom Ocular 6.5-18mm Ortho	***139.95***

NEW ULTIMA EYEPIECES

5, 7.5, 12.5, 18, 24mm, 1 1/4"	**62.95**
30, 42mm 1¼"	**86.95**
15,19,23mm W.A. 1¼"	**102.95**
Special Sale 35mm ultima 1.25"	**64.95**
45, 60mm 2"	**159.95**
80mm 2"	**239.95**
Ultima 2X Barlow (NEW Short Tube Version)	**62.95**

WE SHIP PROMPTLY. ALL TELESCOPES INCLUDE U.S.A. WARRANTY
No Surcharge for MasterCharge or Visa Purchases. Personal checks welcome, will ship without delay. Name must be imprinted on check, also include address, phone, and a copy of major credit card or driver's license for reference. Shipping, handling and insurance additional. 14 day money back guarantee less shipping, with packing and blank warranty card, except film and paper. We ship UPS. Some items special order. All orders are subject to acceptance and verification. Second hand dealer's license #802862. Pictures are for illustration purposes only and may not be exact. **Prices effective till March 3, 1993** **Please address all inquiries and orders to ASTRO. DEPT. #55**

ADORAMA

42 West 18th Street • New York, NY 10011 3

ORDER TOLL FREE **800-223-2500**
ORDERS & INFO **212-741-0052**
FAX # 212-463-7223

TELESCOPE ACCESSORIES

LUMICON

UHC PREMIUM FILTERS		DEEP SKY PREMIUM FILTERS			
1 1/4"	**99.50**	.96"	**59.50**	1 1/4"	**79.50**
48mm f/most 2" EP	**199.95**	2"	**119.50**	48mm	**119.50**

H-BETA				OXYGEN III			
1¼"	**99.50**	48mm	**199.50**	1¼"	**99.50**	48mm	**199.50**

SOLAR FILTER Thousand Oaks Optical

GLASS TYPE 2 Stainless Steel Coated MOUNTED

3.1"	**64.95**	**3.5"/4"**	**75.95**	**5"**	**95.95**
6"	**104.95**	**8"**	**124.95**	**10"**	**139.95**
11"	**149.95**				

New H-Alpha Solar prominance filter w/white light Pre Filter 8" ...**695.**

THREADED SOLAR FILTERS TYPE 2

49mm-58mm	**61.95**	62mm-67mm	**68.95**	72mm-77mm	**73.95**

JIM'S MOBILE

DEC. MOTOR		FOCUS MOTOR	
f/Meade LX3/5/6/MTS	**73.50**	f/Meade LX3	**78.50**
for Celestron 8	**74.95**	f/Meade LX5/6	**78.50**
f/Meade Gem	**79.95**	f/Meade LX200	**79.95**
DSC-Max	**488.00**	f/Celestron 8	**78.95**
NGC Micro Max	**458.95**	NGC-Max	**788.95**
NGC Mini Max	**566.00**		

TELRAD		KWIK FOCUS	
Finder with Mounting Base	**41.95**	Lens Cap 8"	**34.95**
Spare Mounting Base	**8.95**	Lens Cap 10"	**39.95**
Dew Shield for Telrad	**11.95**		

IDAI MIRRORS

IDAI 4.5" f/7.8 (860mm focal leng.) w/Matching Elliptical Flats	**64.95**
IDAI 5" f/8 (980mm focal leng.) w/Matching Elliptical Flats	**89.95**

MEADE PARABOLIC MIRRORS

6" f/8	**139.95**	8" f/6	**194.95**	10" f/4.5	**399.95**
6" f/5	**139.95**	10" f/6	**389.95**		

MEADE ELLIPTICAL FLAT SECONDARY MIRRORS

1.3"	**26.95**	1.83"	**37.95**	2.6"	**53.95**
1.52"	**35.95**	2.14"	**45.95**	3.1"	**84.95**

MEADE RACK & PINION FOCUSER

#67 1 1/4"	**58.**	#640 1 1/4"	**69.**	#680 2"/1.25"	**85.**

CAMERA FOCUSING SCREENS & ACCS

beattie **BEATTIE INTERSCREEN PLUS** (4x Brighter)

f/Nikon F/F2/F3	**93.95**	f/Olympus OM1,2,3,4	**62.95**
f/Nikon FE/FE2/FM/FM2/FA	**62.95**	f/Canon T-90	**64.95**
f/Canon EOS	**63.95**	f/Nikon 8008	**62.95**

OLYMPUS

All Matte (1-8)	**21.95**	Varimagni Finder	**79.95**

BINOCULARS

Nikon

Twin Telescope / Binocular

20x120 III extendable a full 70°
for easy skywatching
w/stand & wood carry case **5699.95**

How to choose Binoculars
By Alan Hale
President of Celestron .**$12.95**

SWIFT

GIANT

Observer 11x80 BCF	**249.95**
Satellite 20x80 BWCF	**259.95**
Vanguard 15x60	**179.95**

SPOTTING SCOPES

Telemaster 15-60x60	**209.95**
Searcher 20x40x60 (12.6")	**236.95**
Seeker 80mm (32X)	**229.95**

ZEISS

W/O CASE

8x56 CF GA	**949.95**
15x60 CFT GA	**1449.95**
30x60 BGAT	**1099.95**
Motor Foc f/30x60	**169.95**

SWAROVSKI

8x56 SL	**699.95**
10x50 SL	**619.95**

KOWA

SPOTTING SCOPES
w/20-60x zoom

TSN-1	**589.95**	TSN-2	**574.95**
TSN-3	**929.95**	TSN-4	**899.95**

CELESTRON

GIANT
NEW MULTI-COATED

11x80 MC	**288.00**
NEW 15x80	**293.00**
20x80 MC	**297.00**
Solar Filter f/11x80,20x80	**64.95**
LPR filter set f/above.	**99.95**

ULTIMA SERIES

7x42	**172.**	8x32 w.a.	**172.**
7x50	**239.95**	10x42w.a.	**186.**
10x50	**186.**	8x56	**184.**

PRO SERIES

8x30w.a.	**119.**	7x50	**119.**
8x56	**159.**	9x63	**165.**
10x50w.a.	**119.**	12x50w.a.	**159.**
8-24x50	**199.95**		

ED GLASS SERIES

6.5x44	**400.**	9.5x44	**395.**

NIKON

7x50 SPHP w/cs	**589.95**
10x70 HP w/case	**459.95**

FIELD SCOPES

20-45x60 Zoom	**354.95**
20-45x60 ED Zoom	**559.95**
New Zoom Angle Scope	**459.95**

SPOTTING SCOPES

20x60 Spotter R/C	**169.95**
15-45x60 Spotter R/C	**249.95**
20x Eyepiece	**46.95**
Photo Adapter f/SS	**49.95**

BINOCULAR ACCS

Car Window Mount	**34.95**
Tripod Adapter	**14.95**

CELESTIAL INNOVATIONS

Binocular Support System f/Giant Binoculars	**109.95**
Bushnell Car Window Mount	**29.95**

TELESCOPE ACCESSORIES

DEW SHIELD
Collapsible, fold down easy to store and transport

for Celestron C90	**18.95**
for Meade 2045	**18.95**
f/8" Schmidt Cassegrains	**28.95**
f/10" Schmidt Cassegrains	**38.95**

Heavy Duty Rechargeable DC Power Pack

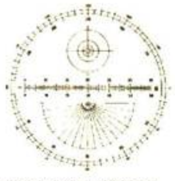
12 Amp Unit........................**86.95**

2", 1¼" & .96"
EYEPIECE FILTERS
(Not all filters available in .96" & 2")

Avail. in the following colors: 1A Skylight; 8 Yellow; 12 Deep Yellow; 15 Deep Yellow; 21 Orange; 23A Red; 25 Red; 38A Blue; 47 Violet; 56 Light Green; 58 Green; 80A Light Blue; 82A Pale Blue; ND 0.3; ND 0.6; ND 0.9

.96" & 1.25"	**Each 11.95**
2"	**Each 26.95**
Buy any 4 filters (.96" or 1.25")	**for only 39.95**
Buy any 8 filters (.96" or 1.25")	**for only 74.95**
Any 4 2" Filters	**84.95**
Polarizer 1 1/4	**13.95**

Celestron's Micro Guide Eyepiece



Features a laser-etched reticle **with built-in cordless illuminator** with adjustable brightness control. The eyepiece is a MC 12.5mm Orthoscopic that can easily be viewed even with eyeglasses.
Guiding with conventional dual-crosshair reticles often forces the user to slightly defocus the guide star to prevent it from suddenly being "hidden" behind the broad grooves - greatly reducing the limiting magnitude. Due to the finely etched lines in the Micro Guide, much fainter, sharply focused stars can be "captured" as guide stars with no reduction in limiting magnitude. **134⁹⁵**

STAR ATLAS and PUBLICATIONS

Sky Atlas 2000.0 Deluxe Color	**39.95**
Sky Atlas 2000 Field	**16.95**
Uranometria 2000.0 Vol 1 or 2	**38.95**
Bright Star Atlas 2000.	**9.95**
Backyard Astronomers Guide by Dickinson	**39.95**
Sky Catalog 2000.0 Vol 1 or 2	**33.95**
Norton's Sky Atlas *18 Edt*	**37.95**
AAVSO Variable Star Atlas	**49.95**
Edmnd Mag 6 Star Atlas	**16.95**
Celestron Sky Maps	**15.95**
Burnhams Celesitial Handbooks 3 Volume Set	**37.95**
Passport To The Stars	**49.95**
Explore The Sky w/Binocs	**3.95**
The Night Sky	**2.95**
Atlas of Deep Sky Splendors (4th Ed.)	**39.95**
New Solar System 3rd Ed.	**26.95**
Astrophotography by Barry Gordon	**19.95**
Astrophotography II by Patrice Martinez	**19.95**
New Solar System (3rd Edition)	**23.95**

ASTRONOMY SOFTWARE

Dance of the planets	**159.**	EZCosmoso 4.0	**59.95**
The Sky DOS level 2	**79.**	level 3	**139.**
The Sky Windows level 2	**104.**	level 3	**159.**
Lodestar Plus II	**189.95**		
Buil-Thouvenot CCD atlas of deep sky 5¼" complete	**219.95**		

Fujinon FMT-SX Binoculars

10x70

6x30 FMTR-SX w/Rubber Coatings & fashion strap	**348.95**
7x50 FMT-SX with Carry Case & fashion strap	**348.95**
7x50 FMTR-SX w/Rubber Coating & fashion strap	**398.95**
7x50 FMTR-CSX R.C.with Compass & fashion strap	**437.95**
8x30 FMTR-SX Rubber Coated & fashion strap	**348.95**
10x70 FMT-SX with Carry Case & fashion strap	**436.95**
16x70 FMT-SX with Carry Case & fashion strap	**540.95**
Tripod Adapter	**14.95**

BARGAIN BOX

ONE OF KIND (N)=New, (D)=Demo, & (U) used i

CELESTRON

Image Correcter straight 1.25" (N)	**19.95**
Rich field lens (N)	**19.95**

MEADE

T-C Video Adapter (N)	**29.95**

Celestron LPR

(Broad Band)
(**L**ight **P**ollution **R**eduction filters)

LPR A for 1.25" eyepieces	*Only* **49⁹⁵**
LPR B for rear cell of Meade & Celestron Schmidt Cassegrain telescopes	*Only* **59⁹⁵**
LPR C for 2" eyepieces	79.95

New Lanthanum Eyepieces LV Series

2.5, 4mm, 1.25"	**109.00**
5, 6, 9, 10, 15mm, 1.25"	**94.95**
20, 25mm, 1.25"	**109.00**
30mm, 2"	**139.95**

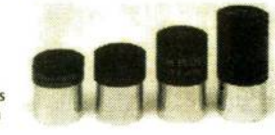
Pro-Optic

Astronomical Accessories

Adorama Exclusive

Adorama is pleased to introduce the Pro-Optic line of telescope accessories. Pro-Optic offers a unique combination of high quality with economical prices

Pro-Optic Plossl 1.25" Eyepieces



The Plossl design has earned a reputation for its image sharpness. However, many astronomers were turned away by its high prices. Now you can can have the Pro-Optic Plossl's at prices which are lower than what you would expect pay for eyepieces of inferior quality. *Field of View is 46°.*

25mm Plossl 1.25"	**41.95**	17mm Plossl 1.25"	**41.95**
10mm Plossl 1.25"	**41.95**	7.5mm Plossl 1.25"	**41.95**

Special Introductory Offer

Buy any one of these eyepieces and get the second one at 1/2 price.

Pro Optic 500mm f/5.6 Maksutov Telephoto/ Spotting Scope

With high-tech white finish

Multi-coated to maximize contrast and sharpness and a built-in field flattener to reduce field curvature.
With its 500mm focal length, it is long enough for close-ups of far away objects but with the f/5.6 optics it is fast enough to be hand held, focuses as close as 5 feet.
With the addition of the 'SS500 Kit you can convert it to a 20X 90mm spotting scope.
The SS500 kit includes a 45° 1.25" Erect Image Diagonal and a 25mm 1.25" Plossl

Pro-Optic 500mm f/5.6 lens	**269.95**
Pro-Optic SS500 Kit	**79.95**

Special Introductory Offer

Buy the 500/5.6 and receive the SS500 Kit for .... only **$39.95**

Pro-Optic Slow Motion Control

With the Slow Motion control attached between your Lens/Spotting Scope and your photographic tripod, you can make accurate slow motion adjustments in altitude and Azimuth in addition the Pro-Optic SMC allows you to make major adjustment in elevation with a separate control knob. The Slow Motion Control fits any tripod with 1/4-20 thread.

Pro-Optic Slow Motion Control........................... **39⁹⁵**

Pro-Optic 45º Erect Image Diagonal 1.25"

Provides an ideal 45° angle for erect image terrestrial viewing with any 1.25" Telescope/Spotting Scope. 42.95

Pro-Optic 90° Star Diagonal 1.25"...........................39.95

SEE OPPOSITE PAGE FOR ORDERING INSTRUCTIONS

FOR SALE — Seven issues of ASTRONOMY between 1973 and 1977. $4 each including postage. Contact Mrs. Walter White, 4921 Providence Rd., San Diego, CA 92117. Phone (619) 274-5265.

FOR SALE — Personal space shuttle photos from Kennedy Space Center. 4x6, $1; 8x10, $5. Also my book, *We Have a Lift-Off*, $7. All plus $1 postage. Contact Ed Case, 4495 Piedras St., Cocoa, FL 32927. Phone (407) 632-2922.

FOR SALE — Lumicon NGC Sky Vector digital setting circles, 8,500-object database. $450 or offer. Contact Dick Evelyn, 3611 Ridgewater Trail, Marietta, GA 30068. Phone (404) 971-2925.

WANTED — Eighteen-year-old novice astronomer seeks correspondence with anyone worldwide interested in astronomy. Contact Kimberly Cherry, 945 Wade Lane, Fallon, NV 89406.

FOR SALE — TeleVue Renaissance 4" refractor, German equatorial mount, tripod, and polar alignment scope. Parkes 32mm 2" Erfle, solar filter, altaz and equatorial mount. $1,300. Contact Barry Evans, (415) 324-0315.

FOR SALE — Celestron C-14 with enhanced coatings. Contact Michael Nuss, 50 Walker Rd., Evanston, WY 82930. Phone (307) 789-6763.

FOR SALE — Meade Schmidt-Cassegrain 8" telescope, model 2080, complete astrophotography set-up. $1,200 plus shipping. Write P.O. Box 2110, Taos, NM 87571. Phone (505) 758-8402.

WANTED — Seventeen-year-old female wants pen friends worldwide in their teens or twenties. Interests: astronomy, geology, animals, and books. Contact Kimberly Markel, 601 Hatfield Dr., Roseburg, OR 97470-9409.

ANNOUNCEMENT — For radio astronomy information, contact Society of Amateur Radio Astronomers, Vincent Caracci, 247 N. Linden St., Massapequa, NY 11758.

WANTED — Correspondence with people interested in astronomy, cosmology, physics, philosophy, Eastern thought, and the existence of God. Contact Rodric Ness, 5580 Whispering Oak Way, Paso Robles, CA 93446.

FOR SALE — Criterion 8" Schmidt-Cassegrain with drive, tripod, wedge, solar filter. $650. Phone (212) 828-3681.

FOR SALE — ASTRONOMY Magazine, August 1973 through December 1991 (233 issues), all in covers. $175 plus shipping. Contact Steve Farkas, 1008 Old Farm Trail, Medina, OH 44256. Phone (216) 725-0335.

WANTED — *Kepler* by M. Kasper, published by Stuttgart in 1948. Any edition or condition, but must be complete. Contact R. Ralston, Box 441, Tahsis, BC V0P 1X0, CANADA.

WANTED — Eighteen-year-old space enthusiast interested in new age music, parapsychological subjects, Catholicism, aesthetics, and nature seeks imaginative correspondence with anyone. Contact Danielle Sauter, 41645 Amberly, Clinton Twp., MI 48038.

FOR SALE — *Beyond the Observatory* by Harlow Shapley (Charles Scribner, NY, 1967). Collection of essays. First edition with dust jacket. $200. Contact Fred L. Krider, 767 E. Main St., Chillicothe, OH 45601. Phone (614) 774-1562.

Readings & Credits

Search for the Lost Lakes of the Moon (page 26)

The Geologic History of the Moon, by Don Wilhelms, (U.S. Geological Survey Professional Paper 1348, 1987). Best up-to-date survey of lunar history; profusely illustrated.

The Moon: An Observing Guide for Backyard Telescopes, by Michael T. Kitt, (Kalmbach Publishing, 1992). A friendly guided tour of the main features visible on the lunar surface using a small telescope.

Atlas of the Moon, by Antonin Rükl, (Kalmbach Publishing, 1992). For those interested in doing lunar exploring from their back yard, this new atlas provides 76 beautiful and detailed maps charting the entire nearside of the Moon, including the polar regions.

Night of the Deep-Sky Observer (page 62)

Galaxies and the Universe, edited by David J. Eicher, (Kalmbach Publishing, 1992). A series of articles originally run in *Deep Sky* magazine takes you on a tour of the sky's best galaxies for backyard telescopes.

Beyond the Solar System, by David J. Eicher, (Kalmbach Publishing, 1992). This economical book describes and illustrates the 100 best deep-sky objects for small telescopes.

Star and Galaxies, edited by David J. Eicher, (Kalmbach Publishing, 1992). This 200-page book collects together "The Backyard Astronomer" series from ASTRONOMY magazine over the last three years.

Burnham's Celestial Handbook, by Robert Burnham, Jr., (Dover Publications, 1978). Contains ample data on nearby stars and astrophysical descriptions of their properties.

The Digital Darkroom (page 72)

Choosing and Using a CCD Camera, by Richard Berry, (Willmann-Bell, Inc., 1992). A guide to selecting the right camera for your application as well as detailed instructions for taking images. Includes software for image calibration.

Astronomical Image Processing, by Richard Berry, (Willmann-Bell, Inc., 1991). Image-processing software with a thorough manual that explains the basics.

"Going Digital with Color," by Richard Berry, ASTRONOMY, July 1992. An introduction to creating color images from calibrated black-and-white CCD images.

Exploring the Spring Sky (page 66)

Stars and Planets, by Donald H. Menzel and Jay M. Pasachoff, (Houghton-Mifflin, 1990). A handy pocket-sized guide containing star maps and descriptions of what you can see in each constellation.

Cover: Ronald Royer; ***p. 4:*** Jack Newton; ***p. 18, top:*** Walter Jaffe, Holland Ford, and NASA; ***bottom:*** T.J. Cornwell and J.M. Uson/NROA; ***p. 20:*** Alan Dressler, Augustus Oemler, James Gunn, Harvey Butcher, and NASA; ***p. 21:*** Johns Hopkins University Applied Physics Laboratory; ***p. 22:*** European Southern Observatory; ***bottom left:*** National Optical Astronomy Observatories; ***bottom right:*** European Southern Observatory and Lifan Wang; ***p. 24:*** Ken Poshedly; ***pp. 26-27:*** Paul Hudson, courtesy Time-Life Books; ***p. 28:*** Thomas L. Hunt; ***p. 29:*** NASA; ***pp. 30-31:*** NASA; ***pp. 32-33:*** Dennis Davidson/NASA; ***p. 34:*** illustration by Michael Carroll; ***pp. 36-39:*** illustrations by Thomas L. Hunt; ***pp. 40-45:*** NASA; ***p. 55:*** Gregory Terrance; ***p. 60:*** Darla Gawelski; Steven G. Davis after James Moeller; ***p. 62, top:*** Steve Quirk; ***bottom:*** Kim Zussman; ***p. 63:*** Alan Dyer; ***p. 64, left:*** David Ratledge; ***pp. 64-65:*** Chuck Vaughn; ***p. 65, right:*** Bill Hood; ***p. 66:*** Daniel J. McGlaun, Jr.; ***pp. 67-71:*** maps by Steven Davis; ***p. 70:*** Daniel J. McGlaun, Jr.; ***p. 72:*** Don Parker, SpectraSource LYNXX CCD camera, 16" telescope; ***p. 73:*** Alan Dyer; ***p. 74:*** Richard Berry, SpectraSource LYNXX CCD camera; ***p. 75:*** Jack Newton, Santa Barbara Instruments ST-6 CCD camera, 25" f/4 telescope, composite of three 5-minute exposures, image processing by Richard Berry; ***p. 76:*** Richard Berry; ***p. 77:*** Paul Boltwood, custom-built CCD camera, 7" Astro-Physics refractor at f/22; ***pp. 78-79:*** illustration by Lee Vande Visse; CCD images by Richard Berry; ***p. 81, top:*** Michael Stecker, 8-inch f/4 reflector, Fuji Super HG 400 film, 30-minute exposure on November 14, 1992; ***bottom:*** Michael Stecker, 8-inch f/4 reflector, Fuji Super HG 400 film, 30-minute exposure on October 25, 1992; ***p. 82, top left:*** Edwin Faughn, 13-inch f/4.5 reflector, November 14, 1992; ***left center:*** John Chumack, 16-inch f/4.5 reflector, T-Max 3200 film, 5-minute exposure, October 26, 1992; ***bottom left:*** Paul Roques, November 14, 1992; ***bottom right:*** Ronald E. Royer, two-color composite made with an 18" f/7 reflector on November 5, 1992; ***p. 83:*** Ronald W. Kohl, 20-inch Cassegrain, STAR I CCD camera, October 21, 1992; ***p. 86:*** Darla Gawelski; ***p. 105:*** JPL/NASA.

VISIT NATURE'S HEAVENLY MUSEUM.

Art by NovaGraphics ©1992

TeleVue's 4" ƒ/5 Genesis APO Refractor

Join us Saturday December 26th as we examine the technology behind the world's most versatile telescope — TeleVue's Genesis Refractor.

TeleVue's advanced optical design makes the Genesis Refractor a versatile telescope for beginners as well as serious astronomers.
(914) 357-9522

TAKE THE NEXT STEP IN YOUR OWN STELLAR JOURNEY WITH SIGHTS & SOUNDS, THE VIDEO MAGAZINE THAT'S DEDICATED TO CUTTING-EDGE CONSUMER ELECTRONICS AND RELATED TECHNOLOGY.

JOURNEY WITH US SATURDAYS AT 4:30 PM E.S.T. ON **CNBC**.

THE POSSIBILITIES ARE ASTRONOMICAL…

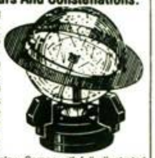
SIGHTS & SOUNDS

Saturdays at 4:30 E.S.T. on CNBC

HARD-TO-FIND, UNIQUE PRODUCTS FOR ASTRONOMERS AND STUDENTS

from America's Largest Mail-Order Market Place of Unusual Values in Telescopes, Binoculars, Magnifiers, Microscopes, Science Kits, Lab Equipment, Toys, Military Surplus, Fiber Optics, Lasers, Solar, Photo and Weather Instruments.

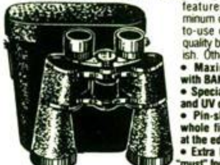
Astropilot Acrylic Illuminated Cosmos Globe Locates Position Of Stars And Constellations.



Our Astropilot Cosmos model is a clear acrylic 5 inch diameter globe depicting 868 stars and all the major constellations of the universe. A horizon ring rests on the globe to determine the visible sky from your location. The globe rests on an attractive black base which contains the illuminator (powered by 4" AA batteries, not included). In the dark the stars, all 868 of them, will glow. Comes with fully illustrated easy-to-use guide book. **AP38,909 $34.95**

Top Quality 10 × 50 High Powered Binoculars For Astronomers And For Surveillance Work.

Our exceptional quality ES Adlerblick 10x50 binoculars were awarded the Gold Label "Inspected" seal from Japan's Telescope Inspection Institute. The lightweight compact design features all-metal aluminum construction, easy-to-use center focus and quality black leatherette finish. Other features include:



- **Maximum brightness with BAK-4 prisms**
- **Special glass materials and UV coatings**
- **Pin-sharp image over whole field of view, even at the edges**
- **Extra high eye point – a "must" for eyeglass wearers**

SPECIAL SALE - SAVE $50 Reg. $340 **AP35,445 $290**

Astronaut Ice Cream.

A delicious, ready-to-eat assortment of freeze dried strawberry, chocolate, and vanilla ice cream that melts in your mouth. It is real ice cream frozen to −40°F, vacuum dried and sealed in a pouch. U.S. astronauts enjoy similar ice cream on space missions. **(Pk. of 2 pouches) AP38,214 $4.50**

Ice Cream Sandwiches (Pkg. of 2) AP52,043 $5.50

Star Machine Personal Planetarium Projects Over 300 Stars and Constellations.

Discover the universe around you with your own personal planetarium. Project stars and constellations onto ceiling or wall. The five constellation masks transmit those stars visible for the special dates that can be dialed in. A red star selector beam helps outline constellation patterns. Outfit also includes star dome with base and battery stand, narrated cassette, pointer and illustrated book of the universe. **AP37,758 $42.95**

This Clever Gadget Will Tell You How High You Are.

Whether you're driving cross country or hiking in the mountains, this Altimeter will tell you how high you are. Shows elevation from sea level to 15,000 feet. Can be mounted to dashboard with self sticking tape (incl.) or has pre-drilled screw holes. Also has built-in barometer. **AP34,544 $39.95**

Add Color To Your Home With A Spectacular Rainbow Light Display.

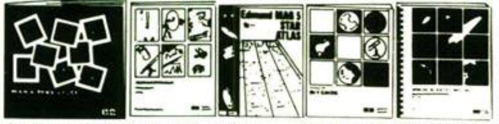
Our equilateral prism mounted in an attractive high tech positioning base, catches the sunlight from your windowsill and projects the ever-changing rainbow patterns over your walls, ceiling and floor. It's almost like being inside a multifaceted diamond. Glass equilateral prism is 2" (50mm) long with 1" (25mm) faces. Black plastic mount is 3"×1⅛×1⅛". **AP38,400 $7.50**

Stars That Glow In The Dark Turn Your Bedroom Ceiling Into The Night Sky.

Assortment of 250 luminous stars that glow in the dark on ceiling or wall. Light up a child's room with the beauty of glowing stars and have fun with astronomy. Easy to apply decals glow after exposure to light. Comes with star chart and instructions to recreate the Big Dipper, Milky Way and the heavens. **AP9521 $4.50**

Keep Your Optics Crystal Clear.

Keep your expensive optical collection in top notch condition with these handy cleaning aids. Set includes our 1" long soft lens brush which gently removes dust and lint, 500 of our specially designed non-abrasive, wet-strength optic cleaning tissues, a can of Dust Off® Junior and two 4 ounce bottles of Lens Luster cleaner - a specially formulated cleaning fluid that cleans optic lenses without leaving any residue. **Complete Lens Cleaning Kit. AP42,697 $25.95**



ORDER ALL 5 BOOKS & SAVE 20%
Reg. $59.95
AP5074
$45.95

Our Popular Astronomy Books And Atlases.

A) Mag 6 Star Atlas. A practical sky guide covering all aspects of amateur astronomy, specially designed for both indoor and outdoor use. Contains detailed data on more than 1,000 celestial objects including multiple stars, variable stars, nebulas and galaxies. Richly illustrated with dozens of photos, diagrams and tables. 50 pages in spiral workbook format. **AP9611 $17.95**

B) Edmund's Famous Best Seller *"All About Telescopes."* Sometimes called *"The amateur astronomer's bible,"* our classic 190 page book is a highly illustrated and easy-to-understand guide. Contents include: *Getting Acquainted with the Telescope; Observing the Sky Show; Photography With Your Telescope; Mirror Grinding and Testing; Telescopes You Can Build; Telescope Mounts; Collimation and Adjustments; Telescope Optics.* The author, Sam Brown, includes all the basic information an amateur needs to be a real professional. **AP9094 $14.95**

C) The Edmund Mag 5 Star Atlas. Lists all stars to magnitude 5.0 down to 60° south declination. Chart scale is ⅛" per degree – perfect for measuring eyepiece field with an ordinary ruler. Includes lists of celestial objects, constellation index, Moon map, sinusoidal projection maps and star lists. Recommended for both the amateur and experienced astronomer. 35 pages. Paperbound. **AP9118 $7.50**

D) The Edmund Sky Guide. Terry Dickinson and Sam Brown's step-by-step procedure for discovering the night sky with the unaided eye, telescope or camera. 35 pages of simplified maps, tables, diagrams and text let you find your way around the heavens without setting circles or memorizing constellations. Excellent companion to *"The Edmund Mag 5 Star Atlas."* **AP9535 $6.50**

E) The Edmund Sky Log. Helps you locate, identify and maintain an organized record of celestial observations. Hints for observing and invaluable lists of what you should look for earn this book our highest recommendation for beginning astronomers. 100 pages. Paperbound. **AP9612 $12.95**

The Edmund RKE® Breakthrough! A New Standard In Eyepiece Performance At Affordable Prices!

Our moderately priced, three-element system outperforms designs using four or more optical elements. The exclusive design of the RKE® eyepiece family coupled with the quality of its optics admits more light, is free from false color and offers a sharply-focused, wide-field view.

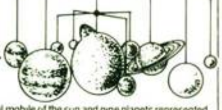
8mm AP30,820 21mm AP30,941
12mm AP30,940 28mm AP30,787
15mm AP 30,819 ***Specify Size***
Reg. $49.95 Save $7 Each
***Sale* $42.95 Each**

SPECIAL BARGAIN!

Complete Kit with Durable Case includes five RKE® eyepieces plus 2.5X Barlow, all custom fitted in a cushioned, foam-insert case. ***Reg. $361 SAVE $36*** **AP30,942 $325**

Solar System Mobile Brings The Planets And Sun Into Your Home, Office or Schoolroom

For students, educators... everyone interested in the heavens, the stars and planets.



Here's a beautiful mobile of the sun and nine planets represented by the best, most striking artists' renderings of NASA photos printed in full color on sturdy cardboard. Measures 3½ feet across when fully assembled. **AP38,075 $19.95**

Build Your Own 2000° Solar Furnace With This Fresnel Lens And Harness The Sun's Rays!

You'll be able to use this precision lens as a solar cooker for heating food, as a kiln for pottery - and even to melt metal or for other solar experiments. Lens has a 15" f.l., 50 lines per inch, measures 10 1/2 x 10 1/2, 1/16 thick. Complete instructions included on how to build the 360° stand and frame shown. **AP70,533 $29.25**

Learn Astronomy In Your Home In 8 Easy Lessons With Detailed Maps, Charts & Books.

Experience The Excitement Of The Outer Limits With Edmund's "Passport To The Stars"

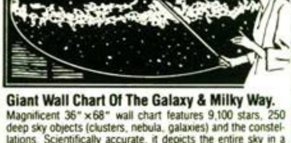
Passport To The Stars is fun, easy and fascinating. It's Edmund Scientific's step-by-step program in observational astronomy. Designed for the beginning amateur astronomer. ***Passport To The Stars*** starts at the very beginning, with identification of the Big Dipper and the North Star (Polaris). From there you progressively develop the skills to locate and track all of the major sky markers.

Your 8-Phase guide to the basics of astronomy will cover the following topics:

- **Phase I. Astronomy From Your Backyard**
- **Phase II. Stars and Constellations**
- **Phase III. Telescopes for Amateur Astronomy**
- **Phase IV. Sun, Moon and Eclipses**
- **Phase V. Planets, Comets and Meteors**
- **Phase VI. Probing Beyond the Solar System (Part 1)**
- **Phase VII. Probing Beyond (Part 2)**
- **Phase VIII. Photographing the Sky Show**

Passport To The Stars is designed so you can participate with or without the aid of optical equipment. **AP9600 $54.95**

Passport To The Stars *has been endorsed by Isaac Asimov, scientist and author of over 200 books! "If I were beginning the study of astronomy today, I couldn't think of a better pathway than* ***Passport To The Stars.****"*



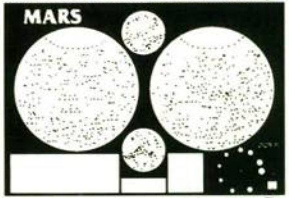
Giant Wall Chart Of The Galaxy & Milky Way.

Magnificent 36"×68" wall chart features 9,100 stars, 250 deep sky objects (clusters, nebula, galaxies) and the constellations. Scientifically accurate, it depicts the entire sky in a single view. Printed on varnished high gloss poster paper. Nucleus of Milky Way is at center of chart. **AP38,074 $24.95**

Digital Thermometer Shows BOTH Indoor AND Outdoor Temperature, Memory For Day's High AND Low!

Now, you'll know at a glance, with large, easy-to-read LED readout numbers, **both** the outside **and** inside temperature. Thermometer also records **high and low readings**. F° or C° selectable −40°F to +122°F. 7x3¼x¾" Easy to mount. Uses 2 "AA" batteries (not incl.). Complete with 10' probe sensor cord. ***$46 Value,*** **SALE! AP38,038 $30**

New! Edmund Scientific's Giant Mars Map.



Explore all the detail and mystery of our neighbor, **The Red Planet**. Designed by world famous cartographer, Antonin Rukl of the Prague Planetarium and Astronomer, George Lovi of New York's Hayden Planetarium, this Map of Mars is the most accurate and visually appealing available. All major features such as craters, volcanoes, mountains, valleys, seas and viking landing sites are identified. Poster also displays basic Mars Data and an Earth to Mars distance chart through 2005. Measures 26" x 38".

Varnish Coated Poster Stock AP52,023 $9.95;
Kimdura Plastic Stock AP52,024 $14.95

FREE 112 PAGE CATALOG

Featured on this page are only a few of the many imaginative products that appear in our new catalog.

Send for your copy today.

Thousands of exclusive, unique and exciting values. Something educational, fascinating and useful for every hobbyist, gadgeteer, student and educator.

Easy To Identify Stars In the Sky With Rotating Star/Planet Locator.

Handy chart shows location of 500 stars and their relationship and location at any time. Plotted by astronomer George Lovi. With 16 page booklet of instructions and simplified celestial drawings. 8½x8½" chart. **AP9227 $2.75**

FREE WITH PURCHASE OF $20 OR MORE

If you qualify for free "locator" be sure to specify order AP5060.

"Red" Flashlight Key-Chain For Astronomers.

Unique compact key ring light is the first with a ***bright red beam*** to provide unparalleled night vision. It works like the red lights used by airplane pilots to read their instrument panels. Made of durable Titanium metal and is ***virtually indestructible.*** Comes with two 1.5V alkaline batteries which last up to 10 years! Easy to add or remove keys. Backed by Tekna's lifetime warranty. Stainless Steel Key Ring pivots 360°, directing the red beam toward keyholes while you unlock the door. **AP38720 $17.95; 2 or more $16.50 Each**

Earthrise...A Giant Size View From The Moon.

Giant 8'6"H×13'8" mural of Earthrise is a vivid, colorful panorama of Mother Nature at her best. Eight easy-to-handle sections. Long-lasting 80 pound poster stock, varnish coated and fully washable. *(Not fully shown).* **AP83,029 $42.95**

Booster Rocket Blasts 100 Feet Into The Air.

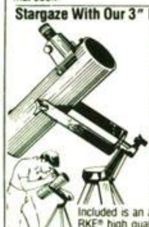
Using air and water as fuel, booster rocket blasts off and at flight's peak, capsule separates from rocket and manned recovery capsule parachutes back to Earth. Virtually indestructible, made of Butyrate plastic.

AP37,231 $10.95

3D Paper Astro-Dome Kit.

Astro-Dome book converts into a three dimensional 20" diameter model of the night sky that's fast and easy to construct. Glows in the dark. Also can be adapted for use in projecting the stars on a ceiling. Perfect for helping to learn the names and locations of stars and constellations as seen from the Northern Hemisphere. Includes a complete handbook of constellations (with diagrams) and an astronomy glossary. 8½"×11" format book. **AP9661 $10.95**

Stargaze With Our 3" F/6 Reflector Telescope.



The perfect telescope for the beginner to look with awe at the vast craters of the moon, the brilliant planets and wonder of the Milky Way. Truly a precision instrument, its finely crafted parabolic mirror, made to 1/8 wave accuracy and factory collimated insures superb resolution for clear sharp viewing. Complete with an equatorial fork mount for full sky access, built-in finder sights and a 1 1/4" friction roller eyepiece mount which accepts a full line of RKE® eyepieces. Included is an all metal 1/4" tripod: our 15mm RKE® high quality eyepiece that insures sharp viewing at 30X magnification. 15" long, 4 1/2" dia.

Edmund Designed and Engineered
Reg. $229 SAVE $20 SALE! **AP31,308 $209**

Edmund's Giant Reference Map Of The Moon.

New, larger size 26"x38" Moon map provides an up-close, detailed view of the lunar landscape. A ready, easy-to-follow source of information about the Moon. Printed in full color, our map details the locations of hundreds of lunar formations. Includes facts on the moon's surface, its orbit, length of the lunar day and night, gravity and how some of the formations were named. **Varnish Coated Poster Stock AP4598 $9.95; Kimdura Plastic Stock AP4599 $14.95**

Radiometer...A Space Age Sphere.

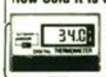
It's fascinating to watch the delicate vanes within this 5" precision-made sphere spin faster and faster illustrating the basic principle of solar heating. When light strikes the vanes it transfers heat, and the vanes begin to move. Works from direct sunlight or artificial light. An attractive "conversation piece". **AP60,082 $6.95**

Our Lowest Price Compact Laser Pointer. It's Lightweight, Measures Less Than 5"

NEW!

Ideal for lecturers, educators, instructors, other professionals. It projects a brilliant red laser dot to focus attention to slide presentations, charts, business and sales meetings at distances up to 300 feet. This compact pen style class IIIa laser pointer is crafted of the finest materials and built to the highest industrial standards. 1 1/2 hours continuous battery life, uses 2 "AAA" batteries incl. Weighs less than 2 oz. Rated output: 3mW at 670nm. Carries 3 year manufacturers limited warranty. **AP52,117 Price Breakthrough! ONLY $89**

Digital Thermometer Reads How Cold It Is Outside.



This new high-tech marvel reads temperature **in your home and outside, too.** Can be wall mounted – just extend the 5 ft. wire sensor out the window and close the window. Operates on one 9V battery (not incl.). Gives readings from −40°F to 199°F, measures 2x3x2¼" ***Reg. $29.95 SAVE $6 SALE!*** **AP34,005 $23.95**

The Chandler Gyroscope – A Classic Favorite For 75 Years.

Demonstrates "gyroscopic inertia" or rigidity in space as first recorded by Isaac Newton. An object rotating about a fixed axis creates a condition in which the axis holds its position with respect to inertial space, no matter how the spinning object's support is moved about. Machined, painted and balance fitted all by hand. Complete with instructions & pedestal. **AP37,265 $5.95**

Edmund Scientific Co.
Dept. 13D3, C921 Edscorp Bldg.
Barrington, NJ 08007

METHOD OF PAYMENT:
☐ Check enclosed ☐ VISA
☐ MasterCard ☐ Diners Club
☐ American Express ☐ Carte Blanche
☐ Discover ☐ Optima

Exp. Date ________
Card Number ________
Bank Number (MasterCard only) ________
Signature ________

☐ **RUSH FREE 112 PAGE FULL COLOR CATALOG**

STOCK NO	QTY	PRICE

Total Price ________
In NJ Add 6% Sales Tax ________
Add $2.50 for postage and handling ________
TOTAL ENCLOSED ________

Name ________
Address ________
City ________ State ________ Zip ________

Serving Science Hobbyists Since 1942

For Phone Orders, Call
1-609-547-8880
for friendly special treatment
Use VISA, MasterCard, Diners Club, Am. Exp., Discover, Carte Blanche or Optima. Call anytime, 24 hours a day.
MOST ORDERS SHIPPED WITHIN 48 HOURS

No Risk Guarantee! If you are not completely satisfied with your purchase, return the merchandise in its original package and we will cheerfully refund your money in full. **We back our products!** Our 45 day unconditional guarantee means you take no risk on any product you buy from us.

Edmund Scientific Co.
Dept. 13D3, C921 Edscorp Bldg., Barrington, NJ 08007

The universe comes to California.

UNIVERSE 93

A two-day national astronomy exposition

Saturday and Sunday, July 10 and 11, 1993
San Diego State University—San Diego, California

Take in some Sun(s), hear the latest astronomy news from experts and shop for astronomy products at Universe 93. It's an astronomical weekend in Southern California sponsored by the Astronomical Society of the Pacific and ASTRONOMY magazine.

- Popular talks by world-famous astronomers
- Workshops and seminars on amateur astronomy
- Astronomy software demonstrations
- Exhibits and sales of telescopes, accessories, books and more
- Optional tour of Palomar Observatory
- An evening star party

UNIVERSE 93

For information on attending or exhibiting, call or write:

ASP Meeting Info
390 Ashton Ave.
San Francisco, CA 94112
(415) 337-1100
Fax (415) 337-5205

TEXAS NAUTICAL REPAIR CO.
Brings You The ULTIMATE 100MM BINOCULAR!

THE ULTIMATE BINOCULAR Designed for the serious observer. Compare these features:

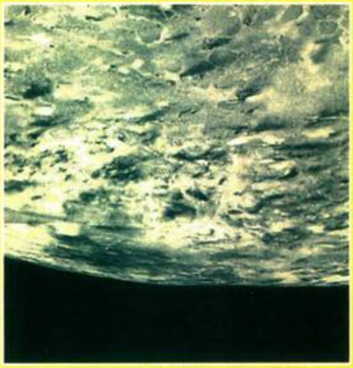
- 100mm four element Petzval-type semi-apochromatic objectives produce high-contrast images.
- 45-degree-angle ocular makes overhead viewing easy.
- Reverse Kellner oculars produce 27mm eye relief for full-field viewing with eyeglasses.
- 20x with 2.5-degree field of view provides breathtaking views.
- single-piece marine-grade Duraluminum body, nitrogen filled to prevent internal fogging.
- Individual click-type focusing for sharpest image.
- Full line of available accessories include: extendable light baffles, illuminated-reticle finder, solar filters, nebular filters, waterproof custom-fitted case, and heavy-duty tripod

For more information contact:

TEXAS NAUTICAL REPAIR COMPANY • 3110 S. SHEPHERD • HOUSTON, TX 77098 • 713-529-3551

COMING IN THE APRIL 1993 ISSUE OF

ASTRONOMY



JPL/NASA

THE TITAN-TRITON CONNECTION Saturn's Titan and Neptune's Triton look very different — but are they really siblings under the skin?

GALAXIES BY THE NUMBERS Learning how galaxies evolve may be as simple as counting 1, 2, 3. . . .

FIRST LOOK AT TOUTATIS Astronomers shot radar at asteroid Toutatis last December and learned it is two objects joined together.

EXPLORE THE VIRGO CLUSTER Over one hundred spirals and ellipticals await backyard observers who hunt through the closest large cluster of galaxies.

AVAILABLE ON YOUR NEWSSTAND MARCH 9

ASTRONOMY

March 1993

Adorama 100, 101
Andromeda Software 90
ARC Software 25
ASP Conference 105
Astronomical Software Associates 80
Astronomics 91
Bethany Sciences 13
Black Forest Observatory 13, 90
BLUE SKY Pages 96, 97
Celestron International 99, 108
City Camera 95
Columbia University Press 23
Coulter Optical Inc 98
Edmund Scientific Company 104
FC Meichsner Co 80
Focus Camera 92, 93
Franklin Mint 17
Fremont, Jim 90
Fujinon, Inc 106
Haag, Robert A. - Meteorites 12
International Dark-Sky Assoc 106
Into The Wind 13
Jim's Mobile (JMI, Inc.) 87
Kalmbach - *Astro Library* 58, 59
Kalmbach - *Marketplace* 84
Khan Scope Centre 97
Los Angeles Optical 87
Lumicon 14, 15
Meade Instruments 2, 3, 8, 9, 10, 11
Murnaghan 80
New England Meteoritical Services 12
Newbridge Communications 19
Orion Telescope Center 56, 57
Parks Optical 91
Readers Exchange 102
Santa Barbara Instrument Group 80
Scope City 88
Select Comfort 95
Shutan Camera & Video 16
Sights & Sounds 103
Software Bisque 7
SpectraAstro Systems 23
Star Hill Inn 12
Technical Innovations 13
Tele Vue Optics, Inc 107
Texas Nautical Rep[air Co 105
Thousand Oaks Optical 88
Tuthill, Roger W. Inc 84
University of Arizona 12
Vista Instruments 80
Wholesale Optics (Pauli's) 85
Wholesale Optics of Penn 23, 87
Zephyr Services 89

FUJINON.
FROM DEEP SPACE TO THE HORIZON.

25x150 MT-SX
25x150 MT-ED
40x150 MT-ED

THE WORLD'S MOST POWERFUL

The most powerful production binoculars on earth are now available with ED low dispersion glass and Fujinon's patented EBC coating. They deliver the ultimate optical performance including high definition, distortion-free images with maximum color correction. Ideal for deep sky studies and comet hunting, the 25x150 and 40x150 models can also bring the horizon within arm's reach during the daytime. Each is equipped with 45° viewing. Built to U.S. Mil Specs, these waterproof binoculars come with a pedestal mount for use on heavy duty tripods or for permanent outdoor installations. The lifetime limited warranty is standard.

25x150 MT-SX also available with straight viewing (not 45°) on special order.

POLARIS
16x70 FMT-SX
10x70 FMT-SX

THE WORLD'S BRIGHTEST

The ultimate in brightness, resolution and optical correction. EBC coating achieves better than 95% light transmission. Flat-field optics reduce distortion and both sagittal and tangential astigmatism to virtually undetectable levels. Providing outstanding balance for comfortable hand held use, each model also offers unprecedented 23mm eye relief (except the 16x70FMT-SX with 12.4mm). Eyepieces with 27mm ocular lenses, are comprised of four groups, five elements. Independently rated best for brightness and clarity, POLARIS models meet U.S. Mil Specs, are waterproof and come with Fujinon's lifetime limited warranty.

Also available, 7x50 FMT-SX

For more information,
FUJINON INC., 10 High Point Drive, Wayne, N.J. 07470 1-201-633-5600
IN HAWAII: Fuji Photo Film Hawaii, Inc. 1-808-942-9400 IN CANADA: Fuji Photo Film Canada, Inc. 1-416-890-6611

FUJINON

International Dark-Sky Association

You can help:

- conserve energy
- reduce air and light pollution
- save the night skies for everyone to use and enjoy.

To learn about *light pollution, energy waste, light trespass,* and related issues, or to join, ($20 basic membership), write to the non-profit **International Dark-Sky Association,** 3545 N. Stewart Ave., Tucson, AZ 85716 U.S.A.

Tele Vue
BIG
Barlow
TELE VUE® 35MM PANOPTIC™

The Universe is extraordinary. Select eyepieces to match!

"Regardless of the type of telescope, the optical system isn't complete without those tiny amplifiers, eyepieces. I've always contended that over the years you will acquire (and unload) several telescopes, but your favorite eyepieces will stay with you. That's why I look at eyepieces as an investment. For peak performance and thorough satisfaction, quality eyepieces are absolutely required. Tele Vue Nagler and Panoptic eyepieces are without question the choice of any observer who knows his stuff. But be forewarned, once you try Nagler and Panoptic eyepieces, you'll lust for a complete set." - S.E. Region Newsletter of the Astronomical League, Vic Menard, New Horizons Editor.

Tele Vue®

Eyepiece literature free; for full-line literature please include $3 for postage and handling
Tele Vue Optics, Dept A, 100 Route 59, Suffern, NY 10901. (914) 357-9522.

THE ULTIMATE PERSONAL TELESCOPE

Celestron's C5 and C5+

SUPERIOR PERFORMANCE IN A CONVENIENT, HIGHLY PORTABLE SMALL PACKAGE

Experience all the C5 has to offer in its two astronomical versions: 1) the C5 – an AC unit and 2) the C5+ – a DC unit with built-in drive controller with hand control. These 5" Schmidt-Cassegrains have the same legendary optical quality as larger Celestron scopes coupled with a rugged, completely redesigned innovative single arm fork mount.

The C5 and C5+ are identical in all respects except the clock drive. For the frequent amateur astronomer on the go or for astrophotography, the DC operated C5+ is the ideal choice – the only choice for a serious portable telescope.

Set up with the C5 is a breeze. Just slip in an eyepiece, adjust focus and you're ready to begin observing. To switch to telephoto or spotting scope use, slip the tube out of the quick release tube saddle and mount on a photo tripod. One minute your C5 is a table top observatory, the next a tripod mounted spotter or 1250mm f/10 telephoto lens.

Standard features of the C5 and C5+:

- Single arm swing-through fork mount
- Novel quick release tube assembly – unique dovetail system with safety locks (Remove the telescope from the fork tine in seconds! No tools required.)
- Dual reading R.A. setting circle works in both Northern and Southern hemispheres
- Reengineered spur gear drive utilizes rigid polar axle with pre-loaded tapered roller bearings in a sturdy and accurate drive system
- DEC axis uses 2 pre-loaded ball bearings for smooth rigid movement – the only manufacturer to do this
- Handles on the fork arm and optical tube for easy handling
- Piggyback platform
- New deluxe table top wedge with built-in bubble level 0° to 90°. Lightweight!
- Weight – 23#. Weight including wedge and optional tripod – less than 35#

Standard accessories:

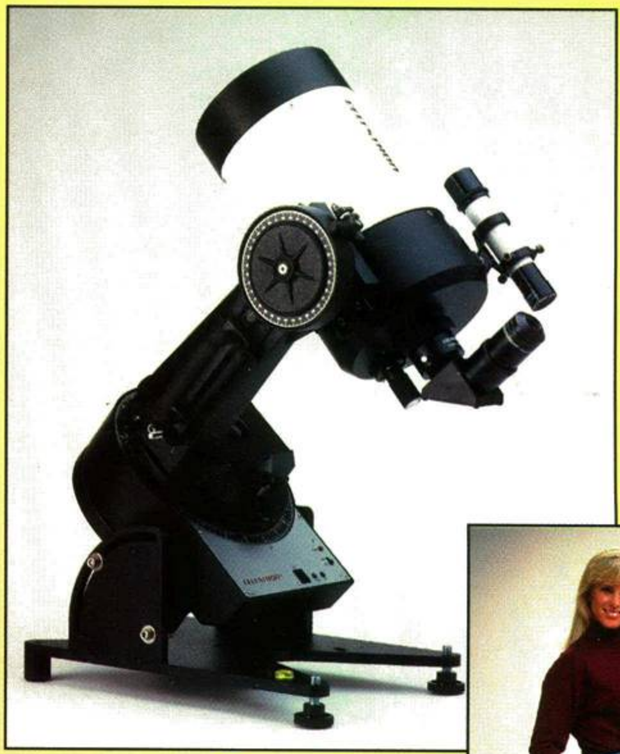
- 5x24 finderscope
- 1-1/4" visual back
- 1-1/4" prism star diagonal
- 1-1/4" Kellner eyepiece 25mm(multi-coated) – 50X
- Built-in photo tripod adapter
- Metal lens cap

A full line of accessories expands the C5's versatility. See the back page for details!

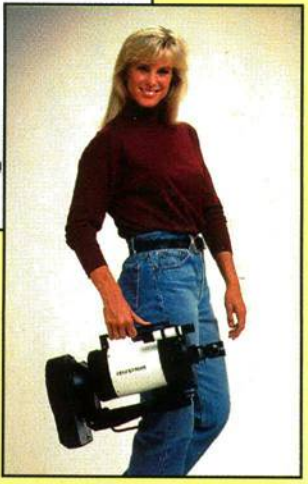
C5 Drive
Electric clock drive — 110V-60Hz power

C5+ Drive
Advanced electronics — DC with built-in electronic drive controller with hand control. The RA motor's main tracking speed is an accurately regulated sidereal rate. The hand control allows fast and slow override of RA tracking speed. It also allows ± operation of the optional DEC motor. LED low power indicator. Guiding rates are compatible with both prime focus and piggyback guiding needs. Runs 50 hours with a 9V alkaline battery. Auto guider compatible!

CELESTRON®
Celestron International
2835 Columbia Street, Torrance, CA 90503
310/328-9560 310/212-5835 (FAX)
LIGHT YEARS AHEAD OF THE COMPETITION



C5



Demonstrating portability

Astrophotography Engineered for Simplicity
The two photos shown below were taken with the C5+ simultaneously – the Orion close-up (left) was prime focus at f/6.3 and the piggyback wide field (180mm f/2.8) (right) were both 15 minute exposures using standard Konica 3200 film and were developed and printed at a one hour photo store. So, with a few genuine Celestron optional accessories and the C5+, astrophotography becomes fairly easy and fulfilling.